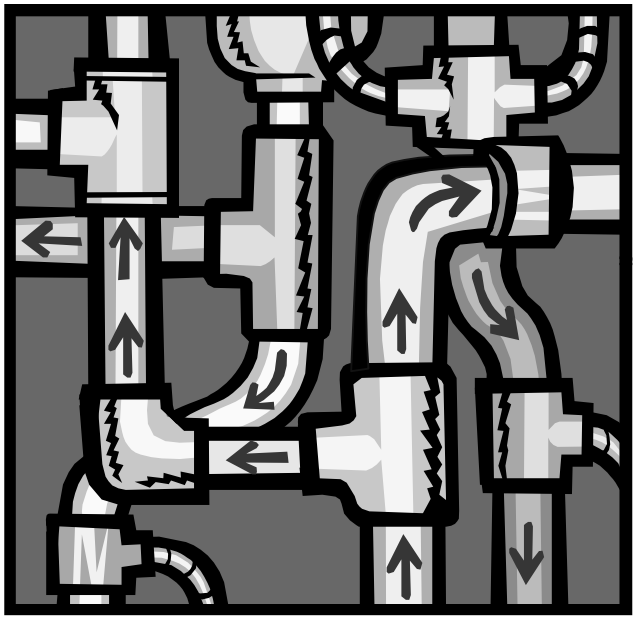
Water Works

Certification Program Guideline



July 2004

Washington State Department of Health
Division of Environmental Health
Office of Drinking Water

DOH #331-109 (Revised)

Water Works Certification Program Guideline

July 2004

For more information or additional copies of this guideline contact:

Water Works Certification Program
Office of Drinking Water
Department of Health
PO Box 47822
Olympia, WA 98504-7822
(360) 236-3141

Mary Selecky
Secretary of Health

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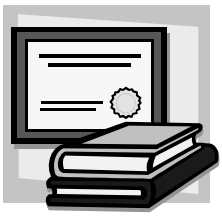

Introduction

Mission Statement

The mission of the Department of Health, Office of Drinking Water is to protect the health of the people of Washington State by providing safe and reliable drinking water.

Certification Program

The Water Works Operator Certification Program is administered by the Department of Health (DOH) in coordination with the Water Works Operator Certification Advisory Committee. DOH is responsible for conducting routine program activities. The program goal is to ensure safe, efficient and effective operation of public water systems. The committee provides advice to DOH.

Water systems are required to employ certified operators to carry out various operational functions. To become certified, operators must meet minimum education and experience requirements and pass an examination. In addition, certified operators must meet a professional growth requirement every three years to maintain their certification status.

The program is self-sufficient, and fees are charged to water systems and operators for services provided by the program. These services include such activities as: enforcement actions, evaluation of education and training, professional growth requirements, career development, and operator listings.

Legal Authority

The Water Works Operator Certification Program operates under the authority of Chapter 70.119 RCW. More detailed and comprehensive program regulations are contained in Chapter 246-292 WAC.

Guideline Purpose

The Water Works Certification Program Guideline is designed to assist water systems and operators in meeting program requirements. To accomplish this, the guideline provides information beyond that presented in regulations, including: how water systems are classified, education and experience requirements of different classifications of operators, procedures for obtaining and renewing certification, and how to meet professional growth requirements.

Guideline Applicability

This document is intended for use by water system purveyors, certified water works operators, and individuals who desire to be certified water works operators in the State of Washington. The guideline is divided into two main sections. The first section contains information regarding water systems and the second section provides information pertaining to operators and the certification process. The guideline will also be used extensively by DOH in carrying out program administrative responsibilities.

For Further Information

Questions about information contained in this guideline, or requests for additional information about the **Water Works Operator Certification Program,** should be directed to:

Water Works Operator Certification Program
Office of Drinking Water
PO Box 47822
Olympia, WA 98504-7822
Website: http://www.doh.wa.gov/ehp/dw/our_main_pages/opcertification.htm

Cheryl Bergener, Program Manager, 360/236-3137,
or toll free in Washington 800/525-2536, Ext. 4

- Certification Requirements for Large Group A Community Systems
- Certification Requirements for Filtered Systems
- Operator Education and Experience Requirements
- Certification Appeals
- General Certification Information

Judy Jones, Deputy Program Manager 360/236-3139,
or toll free in Washington 800/525-2536, Ext. 3

- Certification Requirements for Small Water Systems
- Operator Education and Experience Requirements
- Operator Renewals
- General Certification Information

Denise Garrett-Berry, 360/236-3099,
or toll free in Washington 800/525-2536, Ext. 6

- Certification Compliance
    - Bilateral Compliance Agreements (BCA)
    - Notices of Violation (NOV)
    - Departmental Orders (DO)

Gael Kantz, 360/236-3145,
or toll free in Washington 800/525-2536, Ext. 5

- Temporary Certification Applications and Information
- Contract Operator Requirements and Public Listing
- Certification Compliance

Larry Granish, 360/236-3141,
or toll free in Washington 800/525-2536, Ext. 7

- Examination Scheduling and Locations
- Application Packets
- Operator Address Changes
- Operator Renewals
- Validation Cards

WETRC

Questions about the **Professional Growth Program & the Backflow Assembly Tester Certification Program** should be directed to:

Washington Environmental Training Center (WETRC)
Green River Community College
12401 SE 320th Street M/S WW
Auburn, WA 98092-3699
Website: www.wetrc.org

Peggy Barton, Associate Director, Certification Services 253/288-3369,
or toll free in Washington 800/562-0858

- Water Works Operator Professional Growth Program
- Water Works Training Evaluation and CEU Assignment

David Kingsley, Backflow Assembly Tester Certification Program Manager 253/288-3371,
or toll free in Washington 800/562-0858

- Backflow Assembly Tester Certification
- Backflow Assembly Tester Certification Renewal
- Backflow Assembly Tester Certification Professional Growth Program

Gregory Lund, Training Coordinator 253/288-3373,
or toll free in Washington 800/562-0858

- WETRC Training Information
- Backflow Assembly Tester Examination Registration

Regional Technical Assistance

The Regional Drinking Water Operations offices are open Monday through Friday 8:00 A.M. to 5:00 P.M. Staff is available to assist with most questions immediately. As necessary, other questions will be referred to the appropriate staff for response.

Regional Engineers are responsible for the implementation of the state's drinking water program in assigned counties. They conduct sanitary surveys and special purpose investigations of public water systems and promote needed water facility improvements. They also review and approve water system plans and specifications for system improvements and provide technical assistance to purveyors and local health departments upon request.
Visit our web site at: www.doh.wa.gov/ehp/dw

Department of Health,
Drinking Water Regional Offices

Eastern Regional Office 1500 West 4th Ave, Suite 305 Spokane, Washington 99204 **509-456-3115**	**Counties served:** Adams, Asotin, Benton, Chelan, Columbia, Douglas, Ferry, Franklin, Garfield, Grant, Kittitas, Klickitat, Lincoln, Okanogan, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman and Yakima
Southwest Regional Office Post Office Box 47823 Olympia, Washington 98504-7823 **360-664-0768**	**Counties served:** Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Kitsap, Lewis, Mason, Pacific, Skamania, Thurston and Wahkiakum
Northwest Regional Office 20435 72nd Avenue South, Suite 200 Kent, Washington 98032 **253-395-6750**	**Counties served:** Island, King, Pierce, San Juan, Skagit, Snohomish and Whatcom

After-Hours (*Only*) Hotline for Drinking Water Emergencies
Toll free 1-877-481-4901

Water System Section

Certification Applicability

The Water Works Operator Certification Regulations, chapter 246- 292 WAC requires the following public water systems to have an appropriately certified operator in responsible charge of daily operational activities:

- All Group A* Community or Nontransient Noncommunity (NTNC) systems as defined by chapter 246-292-010 WAC;
- Group A Transient Noncommunity (TNC) systems classified as "Significant Noncompliers" (SNCs); and
- Group A Transient Noncommunity (TNC) systems using surface water or groundwater under the influence of surface water (GWI).

Note: A designated certified operator shall be in responsible charge and available for each operating shift.

**Group A water systems are defined as public water systems that serve a population of 25 or more and/or have 15 or more service connections*.

Mandatory Certified Operator Responsibilities

Public health is protected through competent operators of public water supplies. A certified operator is someone who has met the requirements for the specified operator classification of the Water Works Operator Certification Program. The person(s) in responsible charge of the operation of a Group A community water system, nontransient noncommunity (NTNC) water system, transient noncommunity (TNC) water system classified as a significant non-complier (SNC), and/or a transient noncommunity (TNC) water system using a surface water or groundwater under the influence of surface water (GWI) is required to be certified.

"Responsible charge" means the operator(s) designated by the owner to be the certified operator(s) who makes the decisions regarding the daily operational activities of a public water system, water treatment facility and/or distribution system that will directly impact water quality and/or quantity of drinking water including, but not limited to, decisions concerning process control and system integrity.

The typical public health related responsibilities and activities associated with the operation of a public water system include the following:

1. Ensure that all daily operation and maintenance activities of the water system are completed in accordance with acceptable public health practices and water industry standards.

2. Perform water quality monitoring, maintain adequate records and take follow-up action, if necessary, to comply with state and federal drinking water regulations.

3. Implement preventative maintenance programs; and inspect treatment and other system components for malfunctions; keep adequate records; and make needed repairs.

4. Analyze/review recording instrument readings and laboratory tests; determine sites and causes of any malfunctions; adjust various treatment processes or other components accordingly; and maintain a record of these.

5. Implement a cross-connection control program.

6. Determine remedial actions in emergencies.

Distribution Systems

Distribution systems are defined as Group A public water systems that convey water from the source and/or treatment facilities to consumers. They are classified by the department into five groups:

Population Served	Classification	Certification Requirement
Less than 251	Group S	WDS
251 to 1,500	Group 1	WDM 1
1,501 to 15,000	Group 2	WDM 2
15,001 to 50,000	Group 3	WDM 3
Greater than 50,000	Group 4	WDM 4

The population served is based on information provided by public water systems on their Water Facilities Inventory (WFI) forms. If the population served is not known, multiply the number of service connections by 2.5.

Purification Plants

Purification plants are defined as public water systems that treat or improve the physical, chemical, or bacteriological quality of the system's water to bring the water into compliance with State Board of Health standards. Treatment processes installed to perform water filtration, ion exchange, electrodialysis, reverse osmosis, or iron and manganese removal are included within the scope of the term purification plant. Treatment processes installed to allow in-line fluoridation, in-line chlorination, or chemical additions to inhibit corrosion are not included within the scope of the term purification plant.

1. Purification plants are classified by the department into two categories:

   A. Purification plants utilizing basic filtration technology; or

   B. Purification plants utilizing complex filtration technology.

2. The department classifies purification plants utilizing complex filtration technology into four groups based on the Association of Boards of Certification (ABC) "Purification Plant Criteria". The classification schedule is as follows:

Total Points Assigned	Classification	Certification Requirement
Less than 31	Group 1	BTO
31 to 55	Group 2	WTPO 2
56 to 75	Group 3	WTPO 3
Greater than 75	Group 4	WTPO 4

Sample Scenarios

1. A water system serving a population of 347 people and requires no treatment other than chlorination, requires a WDM 1.

2. A water system serving a population of 136 people and a Group 1 water purification plant rating requires a WDS and a BTO.

3. A water system serving a population of 1,550 people and a Group 2 water purification plant rating requires a WDM 2 and a WTPO 2.

4. A water system serving a population of 26,000 people a Group 3 water purification plant rating, and has three shift operators* in the water purification plant requires a WDM 3, a WTPO 3 and shift operators certified as
   WTPO 2.

   **The operator in responsible charge of each operating shift shall be certified at a minimum of one level lower than the classification of the water purification plant or distribution system. Operating shift is defined as continuous on-site performance of duties in a water purification plant or distribution system.*

Guidelines for Use of ABC Purification Plant Criteria Worksheet

APPLICABILITY OF THE WORKSHEET

WAC 246-292-010 defines "purification plant" as that portion of a public water system that treats or improves the physical, chemical or bacteriological quality of the system's water to bring it into compliance with state board of health standards. Unit processes installed to perform filtration, ion exchange, electrodialysis, reverse osmosis, or iron and manganese removal shall be included within the scope of the term purification plant. **Unit processes installed to allow in-line fluoridation, in-line chlorination, or chemical addition to inhibit corrosion are not included within the scope of the term purification plant.** Exception: a treatment operator shall be responsible for operation of any *unfiltered* Group A surface water or GWI system (WAC 246-292-050).

For multiple treatment facilities on same system: plants are rated individually, however whole system population is used unless the portion of a system served by a particular plant is physically isolated and its service population is known. Operators in systems having multiple treatment facilities must either be assigned to a specific plant, or must be certified for the highest-rated plant on that system. The Water Works Operator Certification Program will maintain rating records for all plants, but will classify systems on the basis of the highest-rated plant.

If a process is provided remotely, but is integral to treatment, then consider it part of the treatment plant (e.g. chlorination in a raw water pipeline used for CT compliance). However, if treatment is supplemental in nature, and operation and monitoring is provided separately from the plant, then this may be considered not a part of the treatment plant (e.g. chlorination at a remote booster station).

SIZE

Maximum population served. Total population receiving water from the plant, including the population served by any consecutive systems.

Design flow. Consider this to be the design capacity of the plant.

WATER SUPPLY SOURCES

Groundwater. Only give points if there is treatment for a primary contaminant (i.e. "purification"). Include Seawater/saltwater sources in this category.

Average raw water quality variability. Applies to all sources (surface and groundwater). Key is the effect on treatment process changes that would be necessary to achieve optimized performance.

- Little or no variation - no treatment provided except disinfection - (0 points)
- Minor variation - e.g. "high quality" surface source appropriate for slow sand filtration - (2 points)
- Moderate variation - chemical feed dosage changes made: at least weekly (3 pts), daily (4 pts), or with each 8-hour shift (6 pts)
- High variation – requires frequent changes in treatment (several times daily), raw water quality variability may be due to agricultural and/or municipal waste discharges - (8 points)
- Extreme variation – may be from periodic serious industrial, agricultural or municipal waste pollution - (10 points)

Raw water is subject to or has elevated. If typically occurring on a routine basis;

- Taste and/or odor levels will be considered elevated when: 1) T&O issue has been identified in a pre-design report, etc., 2) a process has been installed to address, and 3) operational control adjustments are made at least seasonally. Do not give points for T&O when there is no specific additional impact on operation. E.g. if a system is already pre-chlorinating for disinfection, give no points for T&O.
- Color will be considered elevated when levels exceed 75 Color Units (CU) for conventional filtration, 40 CU for direct filtration, or 15 CU for all other technologies, except reverse osmosis (no limits).

- Iron and/or Manganese. Except for applications of manganese greensand treatment, will be considered elevated when their combined level exceeds 1.0 mg/l. (No limits apply for Mn/greensand systems.)
- Turbidity. No restrictions or limitations apply for conventional filtration. Turbidity will be considered elevated when levels exceed 14 NTU for direct and in-line filtration, 10 NTU for slow sand filtration, and 5 NTU for pre-coat (diatomaceous earth), cartridge and bag filters. Limits do not apply to membrane technologies. Note these values apply for turbidity not due to precipitated metals. For unfiltered systems: apply points only if source *blending or source shutdown* is used to achieve/maintain SWTR compliance.
- Coliform will be considered elevated when levels exceed 20,000 CFU/100 mL (as total coliform) for conventional filtration, 5,000 for direct filtration, 500 for direct and in-line filtration, 800 for slow sand filtration, and 50 for pre-coat (diatomaceous earth), cartridge and bag filters. Limits do not apply to membrane technologies. For unfiltereds: Fecal coliform levels which trigger a "filtration decision."
- Algal growths. Raw water will be considered subject to algae growths when treatment processes are specifically adjusted due to the presence of high levels of algae on at least a weekly basis for at least two months each year.

Raw water is subject to periodic pollution: Points are to be accrued when a source of pollution is "consistent enough to cause problems that need to be addressed by the operator" on at least a daily basis.

CHEMICAL TREATMENT/ADDITION PROCESS

Chemical addition – 1 point (each) for any coagulant, coagulant aid, flocculant, or filter aid.

Liquid or powdered chlorine includes on-site generated hypochlorites, and tablet feeders.

UV Disinfection – 5 points.

pH adjustment – chemical addition for process control purposes (e.g. pH adjustment aids coagulation)

Chloramination – 5 points, same as chlorination/chlorine dioxide.

$KMnO_4$ – 2 points. If used with greensand filtration do not give 2 points.

Stability or Corrosion Control – If the same chemical is used for both Corrosion Control and pH adjustment, count points only once -- for Corrosion Control (10 points).

COAGULATION & FLOCCULATION PROCESS

Mechanical mixers are motor driven, turbine or propeller mixers. Also know as back-mixers.

Injection mixers are those that utilize diffusion mixing by pressurized water jets.

In-line blender mixers are in-pipe motor-driven impeller rapid mixers. These do not include in-line static (motionless) mixers. Static mixers get zero points, as do hydraulic mixers (Parshall flume, venturi and weir).

Hydraulic flocculators includes horizontally and/or vertically baffled channels, pipe nozzles, and windowed baffles.

Mechanical flocculators includes shaft driven turbines, blades or paddles (including Walking Beam).

CLARIFICATION/SEDIMENTATION PROCESS

Up-flow solid-contact sedimentation is also known as sludge blanket clarification. Includes such proprietary units as Super-Pulsator. These units include processes for flocculation and sedimentation. Important note: these are not the same as adsorption clarifiers.

Adsorption clarifiers – give 10 points under Special processes/other.

Other proprietary clarification processes – Actiflo, etc. Give 10 points under Special processes/other.

FILTRATION PROCESS

Single media filtration. Sand filter used in complete conventional filtration. Also simple single media processes such as Pyrolox® (pyrolusite) or Birm® filtration –but not greensand (see below). Does not include deep bed monomedia (see "Direct Filtration"), or slow sand filtration.

Microscreens includes membrane filtration (microfiltration and/or ultrafiltration), but not RO (see below).

Cartridge filters includes bag filtration. With or without any non-chemical pre-filtration (e.g. staged cartridges, pressure sand filtration).

Direct filtration includes in-line filtration and deep bed monomedia filtration.

Pressure or greensand filtration – Pressure filtration (for surface sources), and manganese greensand oxidative filters (with or without anthracite cap) –20 points. Points assigned for greensand filtration assume a complete process train, including pretreatment (pre-oxidation), filtration and residuals disposal, but not fluoridation, disinfection, or corrosion control.

SPECIAL PROCESSES

Other. For processes not specifically listed, assign 2 – 15 points based upon comparison with equivalent treatment of similar complexity.

RESIDUALS DISPOSAL

Pick the one category (out of the eight) that best represents disposal practice at the plant.

Discharge to raw water source -- can be recycling to plant, or to lake/reservoir.

On-site disposal – pertains to dry solids residuals disposal.

Land application – pertains to liquid residuals disposal (and there is no NPDES permit).

FACILITY CHARACTERISTICS

No process operation – plant has no automated shutdown capability.

Limited process operation – automated alarm and shutdown for turbidity, chlorine, level, etc.

Moderate process operation – alarms and shutdown, plus partial remote operation of plant.

Extensive/total process operation – alarms and shutdown, full remote operation of plant possible.

Clearwell size applies only to systems treating for a primary contaminant. Total distribution storage available prior to first customer may be counted if it may be drawn upon. If there is no clearwell, points are given.

WASHINGTON STATE DEPARTMENT OF HEALTH

ABC PURIFICATION PLANT CRITERIA WORKSHEET **ABC Classification:**

Water Treatment Plant - address and contact person	
Plant Name	WA WFI #
Contact Name and Title	
Address	
City/State/Zip	
Phone and Fax	

A groundwater supply with only chlorination is considered a distribution system, not a water treatment facility. The addition of any chemical to a public water supply, other than a disinfectant, will be considered a treatment facility and should use this rating worksheet to determine the classification of the facility*. Unless otherwise noted, give full amount of points in the "Your Plant" box.

For example:

	Raw water quality is subject to or has elevated:	Points	Your Plant
Correct:	Taste and/or odor levels	3	3
Incorrect:	Taste and/or odor levels	3	1

Do not double count. If the plant has two horizontal-flow (rectangular basins), **DO NOT** give 10 points, give 5 points. If the plant has more than one type of unit for each process, give points once for each unit.

*With the exception of unit processes installed to allow in-line fluoridation, in-line chlorination, or chemical addition to inhibit corrosion are not included within the scope of the term "purification plant" per WAC 246-292-010.

Item	Points	Your Plant
Size (2 point minimum to 20 point maximum)		
Maximum population or part served, peak day (1 pt minimum to 10 pt maximum) Examples: 27,000 people served = 3 pts 13,000 people served = 2 pts (Round up to the next whole number)	1 pt per 10,000 or part	
Design flow average day or peak month's part flow average day, whichever is larger (1 pt minimum to 10 pt maximum) Examples: 9.2 MGD = 10 pts 4.7 MGD = 5 pts (Round up to the next whole number)	1 pt per MGD or part	
Water supply sources		
Groundwater	3	
Groundwater under the influence of surface water	5	
Surface water	5	
Average raw water quality varies enough to require treatment changes 10% of the time with a range of 0 to 10 with the following guidelines: Little or no variation = 0 points High variation. (Raw water quality subject to periodic serious industrial waste pollution) = 10 points	0—10	
Raw water quality is subject to or has elevated:		
• Taste and/or odor levels	3	
• Color levels	3	
• Iron and/or manganese levels	5	
• Turbidity levels	5	
• Coliform and/or fecal counts	5	
• Algal growths	5	
Raw water quality is subject to periodic:		
• Industrial and commercial waste pollution	5	
• Agricultural pollution	5	
• Urban runoff, erosion, and storm water pollution	3	
• Recreational use (boating, fishing, etc.)	2	
• Urban development and residential land use pollution	2	
Chemical Treatment/Addition Process		
Fluoridation	5	
Disinfection		
• Gaseous chlorine	5	
• Liquid or powdered chlorine	5	
• Chlorine dioxide	5	
• Ozonization (on-site generation)	10	
pH adjustment (Calcium carbonate, carbon dioxide, hydrochloric acid, calcium oxide, calcium hydroxide, sodium hydroxide, sulfuric acid, other)	5	
Stability or Corrosion Control (Calcium oxide, calcium hydroxide, sodium carbonate, sodium hexametaphosphate, other)	10	

PURIFICATION PLANT CRITERIA WORKSHEET (cont.)

Coagulation & Flocculation Process		
Chemical addition (1 pt for each type of chemical coagulant added, maximum 5 pts) (Aluminum sulfate, bauxite, ferrous sulfate, ferric sulfate, calcium oxide, bentonite, calcium carbonate, carbon dioxide, sodium silicate, other)	5	
Rapid mix units		
• Mechanical mixers	3	
• Injection mixers	2	
• In-line blender mixers	2	
Flocculation tanks		
• Hydraulic flocculators	2	
• Mechanical flocculators	3	
Clarification/Sedimentation Process		
Horizontal-flow (rectangular basins)	5	
Horizontal-flow (round basins)	7	
Up-flow solid-contact sedimentation	15	
Inclined-plate sedimentation	10	
Tube sedimentation	10	
Dissolved air flotation	30	
Filtration Process		
Single media filtration	3	
Dual or mixed media filtration	5	
Microscreens	5	
Diatomaceous earth filters	5	
Cartridge filters	5	
Slow sand filters	5	
Direct filtration	5	
Pressure or greensand filtration	20	
Other Treatment Processes		
Aeration	3	
Packed tower aeration	5	
Ion-exchange/softening	5	
Lime-soda ash softening	20	
Copper sulfate treatment	5	
Powdered activated carbon	5	
Special Processes (reverse osmosis, electrodialysis, other)	15	
Residuals Disposal		
Discharge to lagoons	5	
Discharge to lagoons and then raw water source	8	
Discharge to raw water	10	
Disposal to sanitary sewer	3	
Mechanical dewatering	5	
On-site disposal	5	
Land application	5	
Solids composting	5	
Facility Characteristics		
Instrumentation (Choose only one of the following)		
• Use of SCADA or similar instrumentation systems to provide data w/ no process operation	0	
• Use of SCADA or similar instrumentation systems to provide data w/ limited process operation	2	
• Use of SCADA or similar instrumentation systems to provide data w/ moderate process operation	4	
• Use of SCADA or similar instrumentation systems to provide data w/ extensive or total process operation	6	
Clearwell size less than average day design flow	5	
	Total Points	

See WAC 246-292-050 for minimum certification requirements: (Revised 07.10.02)

Class I ..... 30 points or less
Class II ..... 31-55 points
Class III..... 56-75 points
Class IV ..... 76 points and greater

Form Completed by: _____ ..... Date: _____

System Temporary Operator Certification

If a certified operator for a water system leaves their mandatory position for any reason, the system is required to inform the department and fill the vacant position within thirty days. To maintain compliance status the system must hire an appropriately certified operator, a contract operator, or apply for a temporary certification for an individual who is not properly certified and who meets the certification requirements.

When a system wishes to hire an operator who is not certified or not certified at the appropriate level, the Department of Health may issue a temporary certification on request by the system. The temporary will only be granted if DOH criteria have been met. Only one temporary certification may be issued in each instance of any position vacancy and it may be valid for up to twelve months (normally from the date the position became vacant).

To request a temporary certification the system must submit:

- A letter requesting temporary certification for the operator;
- The temporary certification application (needs to be signed by the operator and the system representative); and
- Temporary application fee.

System Certification Fees

Group A system fees shall be as indicated and are subject to change.

Annual System Fees:

System Size (Number of Equivalent Services)	**System Fee****
Less than 601 connections	$103.00
601 through 6,000 Services	$313.00
6001 through 20,000 Services	$417.00
More than 20,000 Services	$629.00

**The late fee shall be based on the water system's classification and shall be an additional 10 percent of the system fee or twenty-seven ($27.00) dollars, whichever is greater.

The system fee for issuance of a temporary certification shall be sixty-eight dollars ($68.00) for each temporary position.

System Compliance and Enforcement

The Department of Health, Office of Drinking Water and the US Environmental Protection Agency (USEPA) consider compliance with the operator certification regulations (Chapter 246-292 WAC) a high priority. The Water Works Operator Certification Program (Certification Program) provides quarterly compliance reports to the USEPA documenting information on system compliance and enforcement efforts.

All systems and certified operators are responsible for providing complete and accurate information to the Certification Program office. The water system representative should report all changes regarding mandatory operator positions. Certified operators should report employment changes, home address, and telephone number corrections. All corrections need to be reported promptly.

All water system enforcement or compliance-related documentation is sent to the system's mailing address.

The Certification Program's compliance/enforcement process is as follows:

Phase 1 – Informal Notification Letters and Telephone Calls

Systems that may be out of compliance with the operator certification regulations are notified and provided technical assistance. Compliance dates are set with every effort made by Certification Program staff to work with systems and operators to help them achieve compliance.

Phase 2 – Notice of Violation (NOV)

At Phase 2, it has been established that a violation of the operator certification regulations has occurred. Systems that have refused to respond to Certification Program contact or that have consistently exceeded scheduled compliance dates are issued a Notice of Violation. There are limited compliance options available at this point.

Phase 3 – State Significant Noncomplier (SSNC)

Failure to respond to a Notice of Violation will result in the water system being categorized as a SSNC. A notification letter of the change in status is sent to the water system. Status as a SSNC for lack of a certified operator will result in the operating permit being categorized as "Red". A "Red" operating permit can affect new loan applications, building permits, sewage permits, etc. A copy of the "Red" operating permit accompanies the SSNC notification letter.

Phase 4 - State Departmental Order (SDO)

Systems that receive a State Departmental Order from the Certification Program are considered to be State Significant Noncompliers (SSNCs).

Phase 5 – Notice of Imposition of Penalties (NIP)

Systems that receive a Notice of Imposition of Penalties for noncompliance with the operator certification regulations may face civil penalties of up to $5,000 per day, per violation. Prosecution as a criminal misdemeanor with fines up to $100 per offense can also be pursued [WAC 246-292-110 (4), (5)].

Other legal actions can be pursued by the Attorney General's office or local prosecutor [WAC 246-292-110 (7)].

Water Works Operator Section

Mandatory Operator Responsibilities

Public health is protected through competent operators of public water supplies. A certified operator is someone who has met the requirements for the specified operator classification of the Water Works Operator Certification Program. The person(s) in responsible charge of the operation of a Group A community water system, nontransient noncommunity (NTNC) water system, transient noncommunity (TNC) water system classified as a significant non-complier (SNC), and/or a transient noncommunity (TNC) water system using a surface water or groundwater under the influence of surface water (GWI) is required to be certified. Once certified, all operators are required to meet renewal and professional growth requirements (see pages –27-30).

"Responsible charge" means the operator(s) designated by the owner to be the certified operator(s) who makes the decisions regarding the daily operational activities of a public water system, water treatment facility and/or distribution system that will directly impact water quality and/or quantity of drinking water including, but not limited to, decisions concerning process control and system integrity.

The typical public health related responsibilities and activities associated with the operation of a public water system include the following:

1. Ensure that all daily operation and maintenance activities of the water system are completed in accordance with acceptable public health practices and water industry standards.

2. Perform water quality monitoring, maintain adequate records and take follow-up action, if necessary, to comply with state and federal drinking water regulations.

3. Implement preventative maintenance programs; and inspect treatment and other system components for malfunctions; keep adequate records; and make needed repairs.

4. Analyze/review recording instrument readings and laboratory tests; determine sites and causes of any malfunctions; adjust various treatment processes or other components accordingly; and maintain a record of these.

5. Implement a cross-connection control program.

6. Determine remedial actions in emergencies.

Contract Operator

Contract operators are those who are designated as the certified operator for three or more public water systems (including Group B), WAC 246-292-055. They must at a minimum be certified as Water Distribution Manager (WDM level determined by the population of the largest public water system operated) and Cross Connection Control Specialist (CCS). Other classifications may be needed depending upon the specific systems involved. Contract operators must be available 24-hours per day and they must provide two copies of all signed operations contracts to the Department of Health within 30 days of the effective date of the contract. These requirements also apply to mandatory operators of Satellite Management Agencies.

Contract operators in compliance with the regulation and who request to be listed, are posted on our website http://www.doh.wa.gov/ehp/dw/Our_Main_Pages/opcertification.htm. If you do not have web access, you may request a copy of this list by contacting Gael Kantz, (360) 236-3145, or toll free, in Washington State, (800) 525-2536, Ext. 5.

Education and Experience Requirements

To assure safe, efficient, and effective operation of public water systems, minimum education and experience requirements for certification have been established. WAC 246-292-060 (1) lists the following minimum education and experience requirements for each water works operator classification and level:

CLASS	LEVEL									
	IT*		1		2		3		4	
	Education	Experience	Education	Experience	Education	Experience	Education	Experience	Education	Experience
WDM	12 years	3 months	12 years	1 year	12 years	3 years	14 years	4 years	16 years	4 years
WTPO	12 years	3 months	12 years	1 year	12 years	3 years	14 years	4 years	16 years	4 years

* In-Training (IT) experience may be fulfilled by three months operating experience or thirty hours of relevant classroom training (three relevant CEUs or college credits).

Water Distribution Specialist (WDS)		Basic Treatment Operator (BTO)		Cross-Connection Control Specialist (CCS)		Backflow Assembly Tester (BAT)	
Education	Experience	Education	Experience	Education	Experience	Education	Experience
12 years	6 months	12 years	6 months	12 years	6 months	NA**	NA**

NOTE: Twelve years education equals a high school diploma, GED or equivalent.

Applicants for Level 1 certification may not substitute equivalent experience or relevant college for any portion of the operating experience requirement. **Operating experience shall be the routine on-site performance of duties in a water purification plant or distribution system. Those duties shall affect plant or system performance and/or water quality.** Providing one year of operating experience has been obtained, applicants for Levels 2, 3, or 4 may make substitutions.
See ***Substitutions for Education and Experience***, page 20.

College means credits earned toward a college degree in course work relevant to the operation or maintenance of a water system; **and** that has an influence on water quality, water supply, or public health protection. College claimed by an applicant may be credited toward the certification requirements when documented on an official transcript or an unaltered copy.

DOH may allow substitutions of a person's relevant experience when the person cannot meet the formal education requirement, or substitute relevant education for experience, in the WDM, WTPO, WDS, BTO, and CCS classifications. See ***Substitutions for Education and Experience***, page 20.

****The BAT classification does not have an education and experience requirement, however, applicants must pass the appropriate examination (see page 31).**

Substitutions for Education and Experience

Education Substitutions

Listed below are accepted education substitutions:

1. A GED is equivalent to a high school diploma.

2. One year of excess operating experience may be substituted for one year of high school or two years of grade school - no limit.

3. Applicants for Level 3 and 4 certification may utilize ***one*** of the following education substitution options:

   Option 1: One year of excess operating experience in a water purification plant or distribution system may be substituted for one year of required relevant college/CEU. This substitution can only be used for **up to half of the education (college) requirement.** If the applicant has less than one year of relevant college/CEU Option 2 is required.

   - OR -

   Option 2: Verification of a high school diploma or GED and three years of excess operating experience in a water purification plant or distribution system with a classification rating not less than one classification lower than the level of certification desired for one year of relevant college - **no limit.**

   Note: Excess operating experience substituted for a WTPO classification must be in a public water purification plant classified at the appropriate level. To determine eligibility utilizing either option, contact the Certification Program Office.

4. One year of college will mean 30 relevant semester credits, 45 relevant quarter credits, or 45 relevant continuing education units (CEU).

5. Operating experience substituted for an education requirement cannot also be applied to the operating experience requirement.

6. On-the-job training that receives college or CEU credit may be applied towards an education requirement or an experience requirement, but not to both.

Experience Substitutions

Listed below are accepted experience substitutions:

1. Three relevant CEU or college credits may be substituted for the three months of operating experience required for OIT applicants.

2. Applicants for certification for Water Treatment Plant Operator 2 through 4 must attain a minimum of half of the operating experience requirement in a public water purification plant utilizing complex filtration technology and classified not less than one classification lower than the level of certification being applied for.

3. Providing one year of operating experience has been obtained, applicants for Water Distribution Manager 2 through 4 may substitute relevant experience, college, CEU, or a combination year for year.

4. Providing one year of operating experience has been obtained, the following experience may be credited, provided the experience is water related:

   A. Experience in a federal, state, county, local, etc., governmental agency;

   B. Experience as an operations consultant;

   C. Experience in industrial water system operations; or

   D. Experience in other areas such as design, analysis, planning, construction, administration, management, etc.

Operator Certification Fees

Operator fees shall be as indicated and are subject to change.

Water Works Operator Fees:

Operator Classification	Application Fee	Reapplication Fee	Annual Renewal Fee	Late Fee
WTPO	$68.00	$33.00	$33.00*	$27.00**
WDM	$68.00	$33.00	$33.00*	$27.00**
WDS	$68.00	$33.00	$33.00*	$27.00**
CCS	$40.00	$33.00	$33.00*	$27.00**
BAT	$40.00	na	$33.00	$27.00
BTO	$40.00	$33.00	$33.00*	$27.00**

* The annual renewal fee for a WTPO, WDM, WDS, BTO, and CCS certification shall be thirty-three ($33.00) dollars regardless of the number of classifications held.

** The late fee for the WTPO, WDM, WDS, BTO, and CCS certification shall be twenty-seven ($27.00) dollars regardless of the number of classifications held.

1. A late fee shall be assessed to operators failing to submit the required fee within the time period specified on the renewal form.

2. The application fee for reciprocity shall be one hundred thirty-eight dollars ($138.00) per classification.

3. The application fee for automatic upgrade (WTPO-IT to WTPO 1 and/or WDM-IT to WDM 1) shall be sixty-six dollars ($68.00).

Reciprocity With Other States

A certificate of competency may be issued, without examination, if the applicant holds a valid water works operator certification issued under the laws of any other state or province provided:

- The out-of-state education, operating experience, and professional growth requirements are equal to, or more stringent than the provisions of WAC 246-292;
- The applicant passed the appropriate Association of Boards of Certification (ABC) written exam with the equivalent passing score; and
- An application has been submitted with proof of a valid water works certification and the appropriate reciprocity fee.

An applicant who is denied reciprocity will be notified of certification options.

Application and Examination Process

Following is the basic procedure for a person seeking initial water works certification. It identifies applicant and DOH responsibilities.

1. A person seeking water works certification must submit to DOH, Water Works Operator Certification Program (Certification Program) the following:

   - ✓ DOH's **current** water works certification application, and supporting documents;
   - ✓ The appropriate application and examination fees;
   - ✓ When required, an official or unaltered copy of college or other transcripts.

2. DOH schedules three examinations a year. Examinations are normally held on the first Tuesday of February, June, and October of each year.

   There may be instances where examinations are scheduled for another day of the week due to exam room availability. If this occurs, the applicant is notified of the change of date.

3. Applications **must be postmarked to DOH, Water Works Operator Certification Program, no later than the application deadline date** listed on the application instructions.

4. Incomplete applications are returned and must be resubmitted and postmarked by the application deadline date. Applications postmarked after the application deadline date will be processed for the next available exam date.

5. Approximately three weeks prior to the exam, all applicants for examination will receive written confirmation from DOH identifying the approved exam, time, date, and location of the exam.

6. Exams will not be administered to individuals who appear for an exam without a written scheduling notice. In the event an individual takes an exam without proper authorization from the Certification Program, DOH will destroy the exam answer sheet before it is graded.

7. Examinations will be closed book. The examination formulas and conversion factors are provided in each operator examination packet. **See Appendices P & Q**.

8. Hand held numeric calculators are allowed. Text entry programmable calculators such as laptops, electronic organizers or equivalent may not be used.

9. All applicants for examination will be required to provide picture identification (i.e. driver license, military identification card, or other government issued identification) prior to taking the examination. **Applicants who do not have picture identification must obtain approval from the Certification Program office two weeks in advance of the exam.**

10. DOH will, in its discretion, conduct oral examinations instead of, or to augment, written examinations to comply with 42 U.S.C. 12101 -- 42 U.S.C. 12213 (Americans With Disabilities Act). To request an oral exam, the applicant must submit a letter citing the special circumstances as justification. The department may request additional justification as deemed necessary. If the department allows a special exam it shall set the time and place, that in its discretion are appropriate, to address the needs of the applicant.

11. DOH purchases all certification exams from the Association of Boards of Certification (ABC).

12. Examination subject information and study references can be found in **Appendices A through I**.

13. Operators certified at the "in-training" level (WDM-IT or WTPO-IT) may apply for automatic upgrade to Level 1 once they meet the education and experience requirements. An Automatic Upgrade Application must be completed and submitted with a current Affidavit of Employment and appropriate fees to the Water Works Operator Certification Program. The effective date of the upgrade will be the date the application is approved.

Renewal Process

All certified water works operators are required to renew their certificates annually. Following is the renewal process:

1. The operator certificate must be renewed January 1 of each year.

2. DOH will mail the water works operator certification renewal notice to the ***operator's home mailing address***. It is the operator's responsibility to keep DOH informed of the current home mailing address. **Failure to notify DOH of a change of address does not constitute a reasonable excuse for failure to renew a certificate or failure to demonstrate professional growth. DOH will not consider appeals from operators who fail to notify the department of address changes.**

3. The initial renewal notice will be mailed the first part of November. If payment has not been received by mid-January, a second and final renewal notice will be mailed.

4. A renewal late fee will be assessed to operators failing to submit the required renewal fee within the time period specified on the initial renewal notice.

5. The department will renew the operator certificate upon payment of the renewal fee and demonstration of professional growth acceptable to DOH within the designated professional growth reporting period. See **Professional Growth**, page 27.

6. The department will notify an operator failing to renew the operator certificate that the certificate is temporarily valid for two months beginning January 1.

7. A certificate not renewed during the two-month period will become invalid. The department will notify the holder of an invalid certificate with a written notice.

8. An operator failing to renew their certification under the provisions of WAC 246-292-090 may reapply for certification and must meet the requirements for a new applicant.

Professional Growth

The Water Works Operator Certification Program requires certified operators to demonstrate continued professional growth in the field in order to be eligible for certification renewal. Under the direction of the Department of Health, the Washington Environmental Training Center (WETRC) at Green River Community College provides course evaluation and Continuing Education Unit (CEU) assignment services to water works training course sponsors and maintains individual professional growth transcripts for each certified operator.

1. **Professional Growth Requirement For Certified Water Works Operators**
   To meet the professional growth requirement, each certified water works operator must accomplish one of the following within the timetable listed below:

   Option 1: Accumulate a minimum of three Continuing Education Units (CEU) or college credit for training that is directly relevant to the operation or maintenance of a water system, **and** that has an influence on water quality, water supply, or public health protection.

   Option 2: Advance by examination in the Water Works Operator Certification Program to a Level 2, 3 or 4, or achieve certification by examination in a different classification as follows:

   - WDM to WTPO, BTO or CCS
   - WTPO to WDM or CCS
   - BTO to WDM, WTPO, WDS or CCS
   - WDS to WDM, WTPO, BTO or CCS
   - CCS to WDM , WTPO or WDS

   The following timetable indicates when certified operators must meet the professional growth requirement:

If You Were Certified:	Then You Must Meet The Professional Growth Requirement Between:
Before 1/1/2001	1/1/2004 and 12/31/2006 and in each 3-year reporting period thereafter.
1/1/2001 - 12/31/2003	Your original certification date and 12/31/2006 and in each 3-year reporting period thereafter.
1/1/2004 - 12/31/2006	Your original certification date and 12/31/2009 and in each 3-year reporting period thereafter.

A. CEU Assignment

DOH requires that CEU used to meet an operator's professional growth requirement for renewal be awarded by:

(1) WETRC, or

(2) A training course sponsor that awards CEU based on a formal evaluation and assignment process following the minimum guidelines established by the International Association of Continuing Education and Training (IACET).

All requests for course evaluation and CEU assignment through WETRC must be submitted to WETRC by the course sponsor. **Requests received less than 15 calendar days prior to the scheduled training date will be returned to the sponsor without evaluation.** Requests for evaluation of multi-session conferences must be submitted at least 30 days in advance to allow adequate time for evaluation.

CEU assignments for courses evaluated by WETRC will be valid for three (3) years from the date of the original CEU assignment. The original assignment will be considered invalid within the three-year period if the course sponsor, title, content, or length changes; or if the course no longer meets current DOH evaluation criteria. At the end of the three-year period, course sponsors will be required to submit a new Request for CEU Evaluation packet.

All courses assigned CEU by WETRC will be issued an identification number. The course sponsor must refer to this identification number on the completed WETRC Participant Roster that is submitted at the conclusion of each training session, and on any other correspondence or inquiries regarding CEU assignment.

Each individual workshop, training session or conference must provide a minimum of three contact hours of training in order to be eligible for CEU evaluation, assignment or recording. The minimum CEU assignment will be 0.3 CEU.

If an operator earns CEU for completing classroom training that has not been evaluated by WETRC or submitted directly by the course sponsor, the operator must submit a *Water Works Classroom Training Submittal Form* available from WETRC. Training curriculum and CEU assignment from the sponsor will be evaluated based on DOH and l IACET criteria. Training that meets DOH and IACET criteria may be accepted toward the operator's professional growth requirement. Training that has not been assigned either CEU or college credit by the sponsor will not be evaluated.

If an operator earns CEU for distance education that has been pre-approved by DOH and completed following the Department's *Distance Education Approval and Examination Procedure*, the operator must submit a *Water Works Distance Education Submittal Form*. Distance education that meets DOH criteria may be accepted toward the operator's professional growth requirement. A current list of pre-approved distance education courses, CEU accepted in Washington, procedures and forms are available from WETRC. Distance education that has not been pre-approved or that has not been completed following the Department's *Distance Education Approval and Examination Procedure* will not be evaluated.

B. Recording and Reporting CEU

It is the certified operator's responsibility to satisfy the professional growth requirement on or before December 31 of the reporting year. This is accomplished through the following process:

(1) DOH will notify WETRC of all certified operators who meet the professional growth requirement using Option 2 above.

(2) The training sponsor or operator must submit verification of successful course completion and CEU or college credit earned to WETRC. Training sponsors submitting verification for all individuals in attendance at a classroom-training event should do so using the *Water Works Operator Professional Growth Training Roster* form available from WETRC. See Section A on page 28 for instructions on submitting completion documentation for distance education, and for training not evaluated or not submitted directly to WETRC by the course sponsor.

(3) WETRC will evaluate all verification of CEU or college credit submitted based on criteria established by DOH and by the IACET. CEU or college credit meeting DOH and IACET criteria may be posted to the operator's professional growth transcript.

If an operator fails to satisfy the requirement by the deadline date, the operator's certificate will not be renewable. If an operator does satisfy the professional growth requirement using Option 1 on or before December 31 of the reporting year, but fails to provide documentation to WETRC, the operator's certificate will be temporarily valid for two months as required by WAC 246-292-090(6). Relevant CEU or college credit earned during the professional growth-reporting period may be submitted to WETRC for consideration until **February 15th** of the period during which the operator holds a temporarily valid certificate. If the documentation submitted satisfies the professional growth requirement, DOH will provide notification to the operator that the certificate is renewable.

When a certified operator satisfies the professional growth requirement, WETRC will provide the operator with a completion letter and a professional growth transcript. This letter is the only official record accepted by DOH as documentation of demonstrating continued professional growth in the field. WETRC will notify DOH that the operator has satisfactorily met the professional growth requirement.

DOH has directed WETRC to restrict record keeping to that required by a certified operator to meet the professional growth requirements specified by law. Therefore, when an operator has met the professional growth requirement for certification renewal for the current reporting period, documentation of additional training will not be accepted by WETRC for the remainder of that reporting period. Keeping track of training beyond that required to meet the professional growth requirement is the operator's responsibility.

CEU or college credit that is earned prior to the operator's certification date, CEU or college credit that have not been earned in the operator's current professional growth reporting period, and CEU less than 0.3 will not be recorded on the operator's transcript.

Certified operators who met the professional growth requirement by using CEU or college credit earned for successful completion or instruction of a course may repeat the same course in a different reporting period. CEU equal to **one-half** of the original course CEU assignment may be applied toward the professional growth requirement for the current reporting period. **No CEU** will be earned for courses repeated during the same reporting period, or for any distance education activities.

Note: For information regarding the appeals process see page 33.

2. Professional Growth Requirement For Certified Backflow Assembly Testers

The Water Works Operator Certification regulation, WAC 246-292-090(4), requires the holder of a Backflow Assembly Tester (BAT) certification to demonstrate professional growth by passing the DOH's BAT professional growth examination during each reporting period. The Washington Environmental Training Center (WETRC) is responsible for proctoring the BAT professional growth examination and administering the BAT professional growth program for DOH.

The following timetable indicates when certified Backflow Assembly Testers must meet the professional growth requirement:

If You Were Certified:	**Then You Must Pass The Bat Professional Growth Examination Between:**
Before 1/1/2001	1/1/2004 and 12/31/2006 and in each 3-year reporting period thereafter.
1/1/2001 - 12/31/2003	Your original certification date and 12/31/2006 and in each 3-year reporting period thereafter.
1/1/2004 - 12/31/2006	Your original certification date and 12/31/2009 and in each 3-year reporting period thereafter.

Note: For information regarding the appeals process see page 33

Backflow Assembly Tester Certification

The Department of Health (DOH) contracts with Green River Community College, Washington Environmental Training Center (WETRC) to administer the State's Backflow Assembly Tester (BAT) Certification Program. WETRC is responsible for the following activities:

- Scheduling and proctoring BAT certification and professional growth examinations following criteria established by DOH;
- Maintaining BAT certification and professional growth database and files;
- Maintaining BAT Public List;
- Issuing new BAT Certificates of Competency;
- Issuing BAT validation cards;
- Processing annual BAT renewal notices and payments;
- Tracking and monitoring compliance with the BAT professional growth requirement;
- Accepting and processing BAT address, name and other information changes;
- Responding to all telephone inquiries regarding BAT certification and professional growth requirements; and
- Initiating correspondence with and notification to BATs regarding certification and professional growth status.

Enforcement elements of the BAT program are administered by the Department of Health (see page 32 Revocation and Suspension).

Revocation and Suspension

Per chapter 246-292-100 WAC,

1. The department may suspend for a specified time or revoke an operator's certificate if the operator:

   (a) Obtains a certificate by fraud or deceit;
   (b) Demonstrates gross negligence in the operation of a purification plant or distribution system; or
   (c) Intentionally violates the requirements of this chapter or any department rules or orders.

2. The department shall provide written notice of violation and reasonable opportunity for correction prior to taking action on revocation or suspension of an operator's certificate.

3. The department shall not initiate action to revoke a certificate until the department has conducted a hearing to consider the appropriateness of revocation.

4. A revocation or suspension action brought under this section shall be conducted in accordance with RCW 43.70.115, chapter 34.05 RCW, and chapter 246-10 WAC.

5. A person whose certificate is revoked is not eligible to apply for certification for one (1) year from the effective date of the final order of revocation.

6. A person whose certificate was revoked and who desires to apply for certification shall apply as a new operator in accordance with WAC 246-292-070.

7. An operator whose certificate is suspended shall continue to meet all renewal requirements in accordance with WAC 246-292-090 in order to maintain certification.

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Appeals Process

Relevancy Review and Appeal Procedure

The WETRC Professional Growth Program Manager will review training submitted by the course sponsor for CEU evaluation and assignment, or training submitted by a certified operator that has already been awarded CEU by the course sponsor. Any training that does not meet the Department of Health's (department's) relevancy criteria will be denied and the submitter will be notified by the Professional Growth Manager of the denial in writing. The course sponsor or certified operator may appeal for a review of the Professional Growth Manager's denial by submitting a request in writing within thirty days of the date on the CEU denial letter to the Water Works Certification Program Manager. The following appeal procedure will be followed:

1. The Water Works Certification Program Manager will distribute the course information to the Professional Growth Relevancy Sub-Committee (Sub-Committee) of the Water Works Operator Certification Advisory Committee (Committee) for review and relevancy determination recommendation. The Sub-Committee will make its relevancy determination recommendation to the Water Works Certification Program Manager within fifteen days of receipt of the request.

2. Upon receipt of the Sub-Committee's recommendation, the Water Works Certification Program Manager will notify the Professional Growth Program Manager of the department's decision.

3. The Professional Growth Program Manager will notify the course sponsor or operator of the Department's decision and appeal procedure within thirty days of receipt of the decision.

The WETRC Professional Growth Manager will refer any training that may require additional evaluation based on the department's relevancy criteria directly to the Department of Health, Water Works Certification Program Manager prior to denial by the WETRC Professional Growth Manager. All such requests for relevancy review submitted directly to Department of Health by the WETRC Professional Growth Manager will follow the procedure outlined above.

Appeal of Other Professional Growth Denials

Denials based on the decision of the Professional Growth Relevancy Sub-Committee, and denials by the WETRC Professional Growth Manager based on the Department's other Professional Growth Program guidelines, may be appealed using the following procedure:

1. The course sponsor or certified operator must file an appeal in writing with the Department of Health, Water Works Certification Program Manager within thirty days of the date on the CEU denial letter.

2. If the appeal is not filed within the thirty days, appeal rights are forfeited.

3. The appeal letter should include justification for the appeal.

4. Appeals will be reviewed by the Water Works Operator Certification Advisory Committee at its next available meeting. The Committee will make its recommendation to the Department of Health, Water Works Certification Program Manager.

5. The Water Works Certification Program Manager will notify the course sponsor or certified operator and the Professional Growth Program Manager of the Department's decision within thirty days of the Water Works Operator Certification Advisory Committee's determination.

6. Decisions on relevancy appeals that have previously been processed through both the Sub-Committee and Committee (i.e. first aid, CPR, flagging, etc.) or professional growth guideline appeals (i.e. training less than 3 hours, no verification of attendance, submitted past the 15 day deadline, etc.) will be made by the Water Works Certification Program Manager.

Certification Renewal Appeals

In order to appeal a non-renewed certification the operator must file the appeal with the Department of Health, Water Works Certification Program Manager within thirty days of the date on the operator certification inactivation letter. If the appeal is not filed within the thirty days, appeal rights are forfeited.

To mail appeals or for further information contact:

Cheryl Bergener, Program Manager
Water Works Operator Certification Program
Department of Health
P. O. Box 47822
Olympia, WA 98504-7822
(360) 236-3137 or
Toll Free in Washington 1-800-525-2536 Ext. 4

Appendix A
Water Distribution Specialist (WDS)
Examination Information

This examination consists of 50 multiple choice questions. Hand-held numeric calculators may be used. The formulas and conversion tables are provided in each examination packet, and are presented in ***Appendix J***. Below is the exam description.

Operate system	
Add liquid disinfectants	X
Monitor, evaluate, and adjust chlorine disinfection	X
Inspect and maintain flow measurement	X
Inspect, maintain, and repair wells	X
Evaluate characteristics of source water	
Bacteriological	X
Biological	X
Chemical	X
Collect, perform and interpret laboratory analyses	
Chlorine demand	X
Chlorine residual	X
Microbiological	X
Operate equipment	
Chemical feeders	X
Instrumentation	X
Pumps	X
Evaluate operation of equipment	
Check speed of equipment	X
Perform preventive maintenance on chemical feeders	X
Read meters	X
Read pressure gauges	X
Perform administrative duties	
Administer safety program	X
Establish record keeping systems for facility operation	X
Record information relating to facility performance	X

Appendix A (continued)

Establish safety plans and apply safety procedures	
Chemical hazard communication	X
Confined space entry	X
Electrical grounding	X
General safety and health	X
Lock-out/tag-out	X
Personal protective equipment	X
Respiratory protection	X

The passing score for these exams is 70%.

Study References

See Appendix C.

Appendix B
Water Distribution Manager (WDM)
Examination Information

This examination consists of from 100 to 180 questions, depending on the level of the examination. An "X" indicates that there will be one or more questions in that area on the examination. The total number of questions and the number of math questions are listed at the bottom of the table. The formulas and conversion table are provided in each examination booklet, and are presented in ***Appendix J***.

	Exam Level			
	WDM 1/IT	**WDM 2**	**WDM 3**	**WDM 4**
System Design				
Assess system demand	**X**	**X**	**X**	**X**
Design thrust blocks		**X**	**X**	**X**
Flushing program	**X**	**X**	**X**	**X**
System layout	**X**	**X**	**X**	**X**
Perform pressure readings	**X**	**X**	**X**	**X**
Read blueprints, readings, and maps		**X**	**X**	**X**
Select type of pipes	**X**	**X**	**X**	**X**
Size mains		**X**	**X**	**X**
National Primary Drinking Water Regulations				
Subpart A - General definitions	**X**	**X**	**X**	**X**
Subpart B - Maximum contaminant levels	**X**	**X**	**X**	**X**
Subpart C - Monitoring and analytical requirements	**X**	**X**	**X**	**X**
Subpart D - Reporting and record keeping				**X**
Subpart I - Control of lead and copper			**X**	**X**
Subpart Q - Public notification of drinking water violations	**X**	**X**	**X**	**X**
Monitor, Evaluate and Adjust Disinfection				
Chlorine disinfection	**X**	**X**	**X**	**X**
Water Quality Parameters and Sampling				
Chlorine demand/residual/dosage	**X**	**X**	**X**	**X**
Coliforms	**X**	**X**	**X**	**X**
Conductivity				**X**
Lead/copper	**X**			**X**
pH	**X**	**X**	**X**	**X**
Temperature		**X**	**X**	
Turbidity		**X**	**X**	**X**
General	**X**	**X**	**X**	**X**

Appendix B (continued)

	WDM 1/IT	WDM 2	WDM 3	WDM 4
System Inspection				
Cross connection surveys/control		X		X
Sanitary surveys	X	X	X	X
Well inspection	X	X	X	X
Install Equipment				
Backflow prevention devices	X	X	X	X
Hydrants		X		
Meters	X	X	X	X
Piping and fitting		X	X	X
Service connections	X	X	X	X
Taps	X	X	X	X
Valves		X		X
Water mains	X	X	X	X
Operate Equipment				
Blowers and compressors		X		
Cathodic protection devices			X	X
Centrifugal pumps	X	X	X	X
Chemical feeders	X	X	X	X
Chlorinators	X	X	X	X
Electrical motors			X	X
Hydrants	X	X	X	X
Instrumentation			X	X
Positive-displacement pumps		X		
Tapping equipment			X	X
Valves	X	X	X	X
General	X	X	X	X
Evaluate and Maintain Equipment				
Backflow prevention devices	X	X	X	X
Cathodic protection devices	X		X	X
Chemical feeders			X	
Chlorinators			X	
Corrosion control			X	X
Electric motors	X			X
Joints	X		X	
Leak detection	X			
Meters	X	X		
Pipe repair	X	X	X	X
Pressure sensors		X		
Pumps	X	X	X	X

Appendix B (continued)

	WDM 1/IT	WDM 2	WDM 3	WDM 4
Valves	X			
Water storage facility	X	X		
Perform Security, Safety and Administrative Duties				
Perform security and safety procedures				
Chemical handling	X		X	X
Confined space entry	X	X	X	X
Contamination		X	X	X
Fire safety		X	X	X
Lock-out/tag-out	X	X	X	X
Personal protective equipment	X		X	X
Trenching		X	X	X
Perform administrative procedures such as				
Administer compliance, emergency preparedness and safety program	X	X	X	X
Develop budget	X	X	X	X
Develop operation and maintenance plan			X	
Plan and organize work activities		X	X	X
Record and evaluate data				X
Respond to complaints	X	X	X	X
Write regulatory authority reports		X		
Total Number of Exam Questions	**100**	**120**	**150**	**180**
Total Number of Math Questions	**6**	**12**	**12**	**16**

Study References

See Appendix D.

Appendix C1
Water Distribution Specialist (WDS)
California State University Text Book Examination References

Exam Objective	Reference Manual
Blowers & Compressors	Water Treatment Plant Operation, Vol. II, Ch. 18
CCC & Backflow	Water Distribution System Operation and Maintenance, Ch. 5
Chemical Feeders	Water Treatment Plant Operation, Vol. II, Ch. 14
Compliance	Water Treatment Plant Operation, Vol. II, Ch. 22 Small Water System Operation and Maintenance, Ch. 2
Conveyance	Water Distribution System Operation and Maintenance, Ch. 3 and 5
Corrosion Control	Water Treatment Plant Operation, Vol. I, Ch. 8
Disinfection	Small Water System Operation & Maintenance, Ch. 7 Water Treatment Plant Operation, Vol. I, Ch. 7
Drives	Water Treatment Plant Operation Vol. II, Ch. 18
Electrical Controls	Water Treatment Plant Operation, Vol. II, Ch. 18 and 19
Electricity	Water Treatment Plant Operation, Vol. II, Ch. 18
Emergency Response	Water Treatment Plant Operation, Vol. I, Ch. 10
Finances	Water Treatment Plant Operation, Vol. II, Ch. 18 and 23
Flow Measurement	Small Water System Operation and Maintenance, Appendix
Flushing	Water Distribution System Operation and Maintenance, Ch. 5
General Safety	Small Water System Operation and Maintenance, Ch. 6 Water Treatment Plant Operation, Vol. II, Ch. 20
Hydrants	Water Distribution System Operation and Maintenance, Ch. 3 and 5
Hydraulics	Small Water System Operation and Maintenance, Ch. 3 and Appendix
Information	Water Treatment Plant Operation, Vol. II, Ch. 23
Laboratory	Water Treatment Plant Operation, Vol. I, Ch.11
Maintenance Management	Water Treatment Plant Operation, Vol. II, Ch. 18 and 23
Maps & Plans	Water Treatment Plant Operation, Vol. II, Ch. 18
Math	Small Water System Operation and Maintenance, Appendix Water Treatment Plant Operation, Vol. I, Appendix
Measuring & Control	Water Treatment Plant Operation, Vol. I, Appendix
Metering	Water Distribution System Operation and Maintenance, Ch. 3
Motors	Water Treatment Plant Operation, Vol. II, Ch. 18
Pipes	Water Treatment Plant Operation, Vol. II, Ch. 18
Planning	Water Treatment Plant Operation, Vol. II, Ch. 23
Pressure Control	Water Distribution System Operation and Maintenance, Ch. 3 and 5
Public Health Principles	Small Water System Operation and Maintenance, Ch. 2
Public Relations	Water Treatment Plant Operation, Vol. II, Ch. 23

Appendix C1 (continued)

Pumps	Water Treatment Plant Operation, Vol. II, Ch. 18
Quality Control & Assurance	Water Treatment Plant Operation, Vol. I, Ch. 10
Safety Administration	Water Treatment Plant Operation, Vol. II, Ch. 20 and 23
Science	Water Treatment Plant Operation, Vol. I, Ch. 7 and Vol. II, Ch. 11
Sources & Characteristics	Small Water System Operation and Maintenance, Ch. 2 Water Treatment Plant Operation, Vol. I, Ch. 2
Storage	Water Distribution System Operation and Maintenance, Ch. 2
Taste & Odor Control	Water Treatment Plant Operation, Vol. I, Ch. 9
Units of Expression	Water Treatment Plant Operation, Vol. I, Appendix
Valves	Water Treatment Plant Operation, Vol. II, Ch. 18
Well Operation	Small Water System Operation and Maintenance, Ch. 3

Appendix C2
Water Distribution Specialist (WDS)
AWWA Bookstore Examination References

Exam Objective	Reference Material
Blowers & Compressors	Water Treatment, Ch. 14
CCC & Backflow	Water Transmission and Distribution, Ch. 11
Chemical Feeders	Basic Science Concepts and Applications, Chemistry 4 and 7
Compliance	Water Quality, Ch. 1 and 4
Conveyance	Water Transmission and Distribution, Ch. 6 and 9
Corrosion Control	Water Treatment, Ch. 9
Disinfection	Basic Science Concepts and Applications, Chemistry 6 and 7 Water Treatment, Ch. 7
Drives	Water Transmission and Distribution, Ch. 12 and 13
Electrical Controls	Water Transmission and Distribution, Ch. 13
Electricity	Basic Science Concepts and Applications, Electricity 2 Water Transmission and Distribution, Ch. 13
Emergency Response	Emergency Planning for Water Utility Management
Finances	Maintenance Management for Water Utilities
Fittings	Water Transmission and Distribution, Ch. 4 and 9
Flow Measurement	Basic Science Concepts and Applications, Hydraulics 7 and Mathematics 11 and 16
Flushing	Water Transmission and Distribution, Ch. 8
General Safety	No reference source specified
Hydrants	Water Transmission and Distribution, Ch. 6
Hydraulics	Basic Science Concepts and Applications, Hydraulics 2, 4, 6 and Mathematics 10
Information	Water Transmission and Distribution, Ch. 15
Laboratory	Water Quality, Ch. 2 – 6

Appendix C2 (continued)

Maintenance Management	Water Transmission and Distribution, Ch. 15
Maps & Plans	Water Transmission and Distribution, Ch. 15
Math	Basic Science Concepts and Applications, Chemistry 4 and 7 Basic Science Concepts and Applications, Hydraulics 2, 6 Basic Science Concepts and Applications, Mathematics 9 – 11, 16, 22, 23
Measuring & Control	Basic Science Concepts and Applications, Mathematics 16 Water Transmission and Distribution, Ch. 10 and 14
Metering	Water Transmission and Distribution, Ch. 10
Motors	Water Transmission and Distribution, Ch. 13
Pipes	Basic Science Concepts and Applications, Mathematics 10 Water Transmission and Distribution, Ch. 1, 2, 5 and 8
Planning	Maintenance Management for Water Utilities
Pressure Control	Water Transmission and Distribution, Ch. 11 and 12
Public Health Principles	Water Quality, Ch. 1 and 4
Public Relations	Water Transmission and Distribution, Ch. 16
Pumps	Basic Science Concepts and Applications, Hydraulics 6 Water Transmission and Distribution, Ch. 12
Quality Control & Assurance	Water Quality, Ch. 9 Water Transmission and Distribution, Ch. 10
Safety Administration	No reference source specified
Science	Basic Science Concepts and Applications, Chemistry 5 and 6
Sources & Characteristics	Water Sources, Ch.1 and 6
Storage	Basic Science Concepts and Applications, Hydraulics 2 and Mathematics 22 Water Transmission and Distribution, Ch. 7
Taste & Odor Control	Water Treatment, Ch. 7
Units of Expression	Basic Science Concepts and Applications, Mathematics 11
Valves	Water Transmission and Distribution, Ch. 3
Well Operation	Basic Science Concepts and Applications, Mathematics 23 Water Sources, Ch. 1 and 2

Appendix D1
Water Distribution Manager (WDM)
California State University Text Book Examination References

Exam Category	Reference Manual
Batteries	Water Treatment Plant Operation, Vol. II, Chapter 18
Blowers & Compressors	Water Treatment Plant Operation, Vol. II, Chapter 18
Cathodic Protection Devices	Water Distribution System O & M, Chapters 2 and 3
CCC & Backflow	Water Distribution System O & M, Chapter 5
Chemical Feeders	Water Distribution System O & M, Chapter 6
Chlorination	Water Distribution System O & M, Chapter 6
Compliance	Water Treatment Plant Operation, Vol. II, Chapter 22
Conveyance	Water Distribution System O & M, Chapter 5
Corrosion Control	Water Distribution System O & M, Chapters 2 & 3
Drives	Water Treatment Plant Operation, Vol. II, Chapter 18
Electrical Controls	Water Treatment Plant Operation, Vol. II, Chapter 18
Electricity	Water Treatment Plant Operation, Vol. II, Chapter 18
Emergency Response	Water Treatment Plant Operation, Vol. II, Chapter 23
Engines	Water Treatment Plant Operation, Vol. II, Chapter 18
Finances	Water Treatment Plant Operation, Vol. II, Chapter 23
Fittings	Water Distribution System O & M, Chapter 3
Flow Management	Water Treatment Plant Operation, Vol. II, Chapter 19
Fluoridation	Water Treatment Plant Operation, Vol. II, Chapter 13
Flushing Systems	Water Distribution System O & M, Chapter 5
General Safety	Water Distribution System O & M, Chapter 7
Generators	Water Treatment Plant Operation, Vol. II, Chapter 18
HVAC	Water Treatment Plant Operation, Vol. II, Chapter 18
Hydrants	Water Distribution System O & M, Chapter 3
Hydraulics	Water Distribution System O & M, Appendix
Information	Water Treatment Plant Operation, Vol. II, Chapter 23
Joints	Water Distribution System O & M, Chapter 3
Laboratory	Water Treatment Plant Operation, Vol. I, Chapter 11, & Vol. II, Chapter 21
Leak Detection & Repair	Water Distribution System O & M, Chapter 5
Maintenance Management	Water Treatment Plant Operation, Vol. II, Chapter 23
Maps & Plans	Water Distribution System O & M, Chapter 5
Math	Water Distribution System O & M, Appendix
Measuring & Control Systems	Water Treatment Plant Operation, Vol. II, Chapter 19
Metering	Water Distribution System O & M, Chapter 3
Motors	Water Treatment Plant Operation, Vol. II, Chapter 18
Personnel	Water Treatment Plant Operation, Vol. II, Chapter 23
Pipes	Water Distribution System O & M, Chapter 3
Planning	Water Treatment Plant Operation, Vol. II, Chapter 23
Pressure Control	Water Distribution System O & M, Chapter 5
Public Health Principles	Water Treatment Plant Operation, Vol. I, Chapter 2
Public Relations	Water Treatment Plant Operation, Vol. II, Chapter 23

Appendix D1 (Continued)

Pumps	Water Distribution System O & M, Chapter 5 Water Treatment Plant Operation, Vol. II, Chapter 18
Quality Control & Assurance	Water Distribution System O & M, Chapter 5
Rolling Stock	Water Treatment Plant Operation, Vol. II, Chapter 18
Safety Administration	Water Distribution System O & M, Chapter 7
Safety Equipment	Water Distribution System O & M, Chapter 7
Science	Water Distribution System O & M, Appendix
Security	Water Treatment Plant Operation, Vol. II, Chapter 23
Sources & Characteristics	Water Treatment Plant Operation, Vol. I, Chapter 2
Storage	Water Distribution System O & M, Chapter 2
Transformers	Water Treatment Plant Operation, Vol. II, Chapter 18
Units of Expression	Water Distribution System O & M, Appendix
Valves	Water Distribution System O & M, Chapters 3 & 5
Well Operation	Small Water System O & M, Chapter 3

Appendix D2
Water Distribution Manager (WDM)
AWWA Bookstore Examination References

Exam Objective	Reference Material
Blowers & Compressors	Water Treatment, Ch. 14
Cathodic Protection Devices	Water Transmission and Distribution, Ch. 8
CCC & Backflow	Water Transmission and Distribution, Ch. 11
Chemical Addition	Basic Science Concepts and Applications, Chemistry 4 and 7
Chemical Feeders	Basic Science Concepts and Applications, Chemistry 4 and 7
Compliance	Water Quality, Ch. 1 and 4
Conveyance	Water Transmission and Distribution, Ch. 3, 4, 5, 6, 9
Corrosion Control	Basic Science Concepts and Applications, Chemistry 6 Water Transmission and Distribution, Ch. 8 Water Treatment, Ch. 9
Disinfection	Basic Science Concepts and Applications, Chemistry 6 and 7 Water Treatment Ch. 7
Drives	Water Transmission and Distribution, Ch. 12 and 13
Electrical Controls	Basic Science Concepts and Applications, Electricity 1
	Water Transmission and Distribution, Ch. 13
Electricity	Basic Science Concepts and Applications, Electricity 2 Water Transmission and Distribution, Ch. 13
Emergency Response	Emergency Planning for Water Utility Management
Engines	Water Transmission and Distribution, Ch. 13
Finances	Maintenance Management for Water Utilities
Fittings	Water Transmission and Distribution, Ch. 4 and 9
Flow Measurement	Basic Science Concepts and Applications, Mathematics 11 and 16 and Hydraulics 7
Fluoridation	Basic Science Concepts and Applications, Chemistry 7 Water Treatment, Ch. 8
Flushing	Water Transmission and Distribution, Ch. 8
General Safety	No reference source specified
Hydrants	Water Transmission and Distribution, Ch. 6
Hydraulics	Basic Science Concepts and Applications, Hydraulics 2 – 6 and Mathematics 10
Information	Water Transmission and Distribution, Ch. 15
Iron & Manganese Removal	Water Treatment, Ch. 10
Joints	Water Transmission and Distribution, Ch. 2
Laboratory	Water Quality, Ch. 2-6
Leak Detection & Repair	Water Transmission and Distribution, Ch. 8
Maintenance Management	Water Transmission and Distribution, Ch. 12 and 15
Maps & Plans	Water Transmission and Distribution, Ch. 15
Math	Basic Science Concepts and Applications, Chemistry 4 and 7 Basic Science Concepts and Applications, Hydraulics 1- 8 Basic Science Concepts and Applications, Mathematics 9 – 11, 16, 22 and 23

Appendix D2 (continued)

Measuring & Control	Basic Science Concepts and Applications, Mathematics 16 Water Transmission and Distribution, Ch. 10 and 14
Metering	Water Transmission and Distribution, Ch. 10
Motors	Basic Science Concepts and Applications, Hydraulics 6 Water Transmission and Distribution, Ch. 13
Personnel	Maintenance Management for Water Utilities
Pipes	Basic Science Concepts and Applications, Hydraulics 5 and Mathematics 10 Water Transmission and Distribution, Ch. 1, 2, 5 and 8
Planning	Maintenance Management for Water Utilities
Pressure Control	Water Transmission and Distribution, Ch. 11 and 12
Public Health Principles	Water Quality, Ch. 1 and 4
Public Relations	Water Transmission and Distribution, Ch. 16
Pumps	Basic Science Concepts and Applications, Hydraulics 6 Water Transmission and Distribution, Ch. 12
Quality Control & Assurance	Water Quality, Ch. 9 Water Transmission and Distribution, Ch. 10
Reports	No reference source specified
Safety Administration	No reference source specified
Science	Basic Science Concepts and Applications, Chemistry 2, 5 and 6
Sources & Characteristics	Water Sources, Ch. 1-3 and 6
Storage	Basic Science Concepts and Applications, Hydraulics 2 and Mathematics 22 Water Transmission and Distribution, Ch. 7
System	Water Transmission and Distribution, Ch. 1 and 8
Taste & Odor Control	Basic Science Concepts and Applications, Chemistry 7 Water Treatment, Ch. 7
Trenching	Water Transmission and Distribution, Ch. 4
Units of Expression	Basic Science Concepts and Applications, Chemistry 7 and Mathematics 11
Valves	Water Transmission and Distribution, Ch. 3
Well Operation	Basic Science Concepts and Applications, Mathematics 6 and 23 Water Sources, Ch. 1 and 2

Appendix E
Basic Treatment Operator (BTO)
Examination Information

The examination consists of 75 multiple choice questions. Hand-held numeric calculators may be used. The formulas and conversion tables are provided in each examination packet, and are presented in ***Appendix J***.

Evaluate characteristics of source water	
Biological	X
Physical	X
Collect, perform, and interpret laboratory analyses	
Chlorine residual	X
Giardia lamblia	X
pH	X
Monitor, evaluate, adjust system	
Cartridge/bag filters	X
Chlorine disinfection	X
Slow sand filters	X
Flow measurement	X
Evaluate operation of equipment	
Read flow and hour meters	X
Read pressure gauges	X
Operate equipment	
Chemical feeders	X
Chlorinators	X
Manual controlled valves	X
Pumps and motors	X
Perform maintenance	
Pumps and motors	X
Perform safety procedures	
Confined space entry	X
Electrical	X
Lock-out/tag-out	X
Trenching and shoring	X

Appendix E (continued)

Establish emergency plan and respond to emergencies	
Equipment failure	X
Regulation violation	X
System upset (disinfection failure, contamination, power outage, etc.)	X
Perform administrative duties	
Promote public relations	X
Record information for finances, maintenance, system operation, water quality compliance (pH, chlorine residual, etc.)	X

The passing score for this exam is 70%.

Study References

See Appendix G.

Appendix F
Water Treatment Plant Operator (WTPO) Examination Information

This examination consists of from 100 to 180 questions, depending on the level of the examination. An "X" indicates that there will be one or more questions in that area on the examination. The total number of questions and the number of math questions are listed at the bottom of the table. The formulas and conversion table are provided in each examination booklet, and are presented in ***Appendix J***.

	Exam Level			
	WTPO 1/IT	**WTPO 2**	**WTPO 3**	**WTPO 4**
Monitor, Evaluate and Adjust Treatment Processes				
Source Water Treatment (algae control, chemical treatment)				**X**
Intake Structure	**X**	**X**	**X**	**X**
Chemical Treatment/Addition (fluoridation, chlorine disinfection, ozone disinfection, uv disinfection, pH adjustment, corrosion control)	**X**	**X**	**X**	**X**
Coagulation & Flocculation (chemical coagulants, rapid mix units, flocculation tanks)		**X**	**X**	**X**
Clarification/Sedimentation (sedimentation basins, up-flow solids-contact clarification, inclined-plate sedimentation, tube sedimentation)		**X**	**X**	**X**
Filtration (gravity/rapid sand, membrane, cartridge, slow sand, direct, pressure or greensand, diatomaceous earth)	**X**	**X**	**X**	**X**
Other Treatment Processes (aeration, ion exchange softening, iron and manganese removal, lime-soda ash softening, gac, pac, aids)		**X**	**X**	**X**
Residuals Disposal			**X**	**X**
National Primary Drinking Water Regulations				
Subpart A – General definitions	**X**	**X**	**X**	**X**
Subpart B – Maximum contaminant levels	**X**		**X**	**X**
Subpart C – Monitoring and analytical requirements	**X**	**X**	**X**	**X**
Subpart E – Special regulations	**X**			
Subpart G – National revised primary drinking water regulations		**X**	**X**	**X**
Subpart H – Filtration and disinfection			**X**	**X**
Subpart I - Control of lead and copper	**X**	**X**	**X**	**X**
Subpart L – Disinfection residuals, disinfection byproducts, and disinfection byproduct precursors		**X**	**X**	
Subpart O – Consumer confidence reports	**X**			
Subpart P – Enhanced filtration and disinfection			**X**	**X**
Subpart Q – Public notification of drinking water violations	**X**	**X**		

Appendix F (continued)

	WTPO 1/IT	WTPO 2	WTPO 3	WTPO 4
Collect Samples and Interpret Analysis				
Alkalinity			X	X
Chlorine demand	X			
Chlorine residual	X			
Disinfectant by-products (THM)			X	X
Dissolved oxygen			X	X
Hardness			X	X
Inorganic (heavy metal) chemical				X
Iron/manganese			X	X
Jar test			X	
Microbiological	X	X	X	X
pH	X			X
Sampling/Lab equipment	X	X	X	X
Settleable solids			X	
Temperature	X	X	X	X
Turbidity		X	X	X
Volatile organic chemicals		X	X	X
Perform Process Control Laboratory Analysis				
Alkalinity		X	X	X
Chlorine residual	X	X	X	X
Jar test				X
Microbiological	X		X	X
pH	X	X	X	
Sampling/Lab equipment		X		X
Temperature	X	X	X	X
Turbidity		X	X	X
Evaluate Characteristics of Source Water				
Bacteriological	X	X		X
Biological			X	X
Chemical	X	X	X	X
Physical	X	X	X	X
Operate Equipment				
Chemical feeders	X	X	X	X
Hydraulic equipment		X	X	X
Prime movers/drivers	X	X	X	X
Valves	X	X	X	X
Water pumps	X		X	X

Appendix F (continued)

	WTPO 1/IT	WTPO 2	WTPO 3	WTPO 4
Evaluate and Maintain Equipment				
Evaluate operation of equipment:				
Inspect equipment for abnormal conditions		X	X	X
Read charts		X	X	X
Read meters	X	X	X	
Read pressure gauges	X	X	X	X
Perform Maintenance		X		
Blowers, compressors, and pneumatics			X	X
Chemical feeders	X	X	X	
Instrumentation	X	X	X	X
Pipes	X	X	X	X
Prime movers/drivers		X	X	X
Water pumps	X		X	X
Water treatment filters	X			X
Perform Security, Safety and Administrative Duties				
Perform security and safety procedures				
Chemical handling	X	X	X	X
Confined space entry	X	X		X
Lock-out/tag-out	X	X	X	X
Personal protective equipment	X			
Spill response	X		X	X
Perform administrative procedures such as				
Administer compliance, emergency preparedness and safety program		X	X	X
Record and evaluate data	X			
Total Number of Exam Questions	**100**	**120**	**150**	**180**
Total Number of Math Questions	**8**	**12**	**18**	**25**

The passing score for this exam is 70%.

Study References

See Appendix G

Appendix G1
Water Treatment Plant Operator (WTPO)
Basic Treatment Operator (BTO)
California State University Text Book Examination References

Exam Category	Reference Manual
Aeration	Water Treatment Plant Operation, Vol. I, Chapter 9
Batteries	Water Treatment Plant Operation, Vol. II, Chapter 18
Blowers & Compressors	Water Treatment Plant Operation, Vol. II, Chapter 18
Cathodic Protection Devices	Water Treatment Plant Operation, Vol. I, Chapter 8
CCC & Backflow	Water Distribution System O & M, Chapter 5
Chemical Feeders	Water Treatment Plant Operation, Vol. II, Chapter 13
Chemical Precipitation Softening	Water Treatment Plant Operation Vol. II, Chapter 14
Clarification	Water Treatment Plant Operation, Vol. I, Chapter 5
Coagulation & Flocculation	Water Treatment Plant Operation, Vol. II, Chapter 4
Compliance	Water Treatment Plant Operation, Vol. II, Chapter 22
Corrosion Control	Water Treatment Plant Operation, Vol. I, Chapter 8
Dechlorination	Water Treatment Plant Operation, Vol. II, Chapter 16
Defluoridation	Water Treatment Plant Operation, Vol. II, Chapter 16
Demineralization	Water Treatment Plant Operation, Vol. II, Chapter 16
Desalinization	Water Treatment Plant Operation, Vol. II, Chapter 16
Disinfection	Water Treatment Plant Operation, Vol. I, Chapter 7
Drives	Water Treatment Plant Operation, Vol. II, Chapter 18
Electrical Controls	Water Treatment Plant Operation, Vol. II, Chapter 19
Electricity	Water Treatment Plant Operation, Vol. II, Chapter 18
Electrodialysis	Water Treatment Plant Operation, Vol. II, Chapter 16
Emergency Response	Water Treatment Plant Operation, Vol. II, Chapter 23
Engines	Water Treatment Plant Operation, Vol. II, Chapter 18
Filtration	Water Treatment Plant Operation, Vol. I, Chapter 6
Finances	Water Treatment Plant Operation, Vol. II, Chapter 23
Fittings	Water Treatment Plant Operation, Vol. II, Chapter 18
Flow Management	Water Treatment Plant Operation, Vol. II, Chapter 19
Fluoridation	Water Treatment Plant Operation, Vol. II, Chapter 13
General Safety	Water Treatment Plant Operation, Vol. II, Chapter 20
Generators	Water Treatment Plant Operation, Vol. II, Chapter 18
HVAC	Water Treatment Plant Operation, Vol. II, Chapter 18
Hydrants	Water Distribution System O & M, Chapter 3
Hydraulics	Water Treatment Plant Operation, Vol. I and II, Appendix
Information	Water Treatment Plant Operation, Vol. II, Chapter 23
Ion Exchange	Water Treatment Plant Operation, Vol. II, Chapter 14
Iron & Manganese Removal	Water Treatment Plant Operation, Vol. II, Chapter 12
Joints	Water Treatment Plant Operation, Vol. II, Chapter 18

Appendix G1 (continued)

Exam Category	Reference Manual
Laboratory	Water Treatment Plant Operation, Vol. I, Ch 11, Vol II, Ch 21
Land Application	Water Treatment Plant Operation, Vol. II, Chapter 17
Landfill Solids	Water Treatment Plant Operation, Vol. II, Chapter 17
Maintenance Management	Water Treatment Plant Operation, Vol. II, Chapter 23
Maps & Plans	Water Treatment Plant Operation, Vol. II, Chapter 23
Math	Water Treatment Plant Operation, Vol. I and II, Appendix
Measuring & Control Systems	Water Treatment Plant Operation, Vol. II, Chapter 19
Microscreens	Water Treatment Plant Operation, Vol. I, Chapter 3
Motors	Water Treatment Plant Operation, Vol. II, Chapter 18
Personnel	Water Treatment Plant Operation, Vol. II, Chapter 23
Pipes	Water Treatment Plant Operation, Vol. II, Chapter 18
Planning	Water Treatment Plant Operation, Vol. II, Chapter 23
Public Health Principles	Water Treatment Plant Operation, Vol. I, Chapter 2
Public Relations	Water Treatment Plant Operation, Vol. II, Chapter 23
Pumps	Water Treatment Plant Operation, Vol. II, Chapter 18
Quality Control & Assurance	Water Treatment Plant Operation, Vol. II, Chapter 10
Recirculation	Water Treatment Plant Operation, Vol. I, Chapter 3
Reverse Osmosis	Water Treatment Plant Operation, Vol. II, Chapter 16
Rolling Stock	Water Treatment Plant Operation, Vol. II, Chapter 18
Safety Administration	Water Treatment Plant Operation, Vol. II, Chapter 23
Safety Equipment	Water Treatment Plant Operation, Vol. II, Chapter 20
Science	Water Treatment Plant Operation, Vol. I and II, Appendix
Screening	Water Treatment Plant Operation, Vol. I, Chapter 3
Security	Water Treatment Plant Operation, Vol. II, Chapter 23
Sludge Belt Press	Water Treatment Plant Operation, Vol. II, Chapter 17
Sludge Centrifuges	Water Treatment Plant Operation, Vol. II, Chapter 17
Sludge Drying Beds	Water Treatment Plant Operation, Vol. II, Chapter 17
Sludge Filter Press	Water Treatment Plant Operation, Vol. II, Chapter 17
Sludge Vacuum Filters	Water Treatment Plant Operation, Vol. II, Chapter 17
Sources & Characteristics	Water Treatment Plant Operation, Vol. I, Chapter 2
Storage	Water Distribution System O & M, Chapter 2
Taste & Odor Control	Water Treatment Plant Operation, Vol. I, Chapter 9
Transformers	Water Treatment Plant Operation, Vol. II, Chapter 18
Units of Expression	Water Treatment Plant Operation, Vol. I and II, Appendix
Valves	Water Treatment Plant Operation, Vol. II, Chapter 18
Well Operation	Small Water System O & M, Chapter 3

Appendix G2
Water Treatment Plant Operator (WTPO)
Basic Treatment Operator (BTO)
AWWA Bookstore Examination References

Exam Objective	Reference Material
Adsorption	Water Treatment, Ch. 13
Aeration	Water Treatment, Ch. 14
Blowers & Compressors	Water Treatment, Ch. 14
Cathodic Protection Devices	Water Transmission and Distribution, Ch. 8
CCC & Backflow	Water Transmission and Distribution, Ch. 11
Chemical Pretreatment	Water Treatment, Ch. 14
Chemical Addition	Basic Science Concepts and Applications, Chemistry 4 and 7 Water Treatment, Ch. 7 and 11
Chemical Feeders	Basic Science Concepts and Applications, Chemistry 4 and 7 Water Treatment, Ch. 7 and 11
Clarification	Basic Science Concepts and Applications, Mathematics 10 and 17 - 22 Water Treatment, Ch. 3 and 5
Coagulation & Flocculation	Basic Science Concepts and Applications, Chemistry 6 and 7 Water Treatment, Ch. 4
Compliance	Water Quality, Ch. 1 and 4
Corrosion Control	Basic Science Concepts and Applications, Chemistry 6 and 7 Water Treatment, Ch. 9
Disinfection	Basic Science Concepts and Applications, Chemistry 6 and 7 Water Treatment, Ch. 7
Drives	Water Transmission and Distribution, Ch. 12 and 13
Electrical Controls	Basic Science Concepts and Applications, Electricity 1 Water Transmission and Distribution, Ch. 13
Electricity	Basic Science Concepts and Applications, Electricity 2 Water Transmission and Distribution, Ch. 13
Emergency Response	Emergency Planning for Water Utility Management
Engines	Water Transmission and Distribution, Ch. 13
Filtration	Basic Science Concepts and Applications, Mathematics 19 and 20 Water Treatment, Ch. 6
Finances	Maintenance Management for Water Utilities
Flow Measurement	Basic Science Concepts and Applications, Hydraulics 7 and Mathematics 11 and 16
Fluoridation	Basic Science Concepts and Applications, Chemistry 7 Water Treatment, Ch. 8
General Safety	No reference source specified
Hydrants	Water Transmission and Distribution, Ch. 6
Hydraulics	Basic Science Concepts and Applications, Hydraulics 2 - 6 and Mathematics 10
Information	Water Transmission and Distribution, Ch. 15

Appendix G2 (continued)

Ion Exchange	Basic Science Concepts and Applications, Chemistry 7
	Water Treatment, Ch. 12
Iron & Manganese Removal	Water Treatment, Ch. 10
Joints	Water Transmission and Distribution, Ch. 2
Laboratory	Basic Science Concepts and Applications, Chemistry 4 - 7
	Water Quality, Ch. 1-6
Leak Detection & Repair	Water Transmission and Distribution, Ch. 8
Maintenance Management	Water Transmission and Distribution, Ch. 12 and 15
Maps & Plans	Water Transmission and Distribution, Ch. 15
Math	Basic Science Concepts and Applications, Chemistry 4 and 7
	Basic Science Concepts and Applications, Hydraulics 1 - 8
	Basic Science Concepts and Applications, Mathematics 9 - 23
Measuring & Control	Basic Science Concepts and Applications, Mathematics 16
	Water Transmission and Distribution, Ch. 10 and 14
Metering	Water Transmission and Distribution, Ch. 10
Microscreens	Water Treatment, Ch. 3
Motors	Water Transmission and Distribution, Ch. 13
Personnel	Maintenance Management for Water Utilities
pH Adjustment	Water Treatment, Ch. 4
Pipes	Water Transmission and Distribution, Ch. 1 and 4
	Basic Science Concepts and Applications, Hydraulics 5 and Mathematics 10
Planning	Maintenance Management for Water Utilities
Pressure Control	Basic Science Concepts and Applications, Hydraulics 2
	Water Transmission and Distribution, Ch. 11 and 12
Public Health Principles	Water Quality, Ch. 1 and 4
	Water Sources, Ch. 6
Public Relations	Water Transmission and Distribution, Ch. 16
Pumps	Basic Science Concepts and Applications, Hydraulics 6
	Water Transmission and Distribution, Ch. 12
Quality Control & Assurance	Water Quality, Ch. 9
	Water Treatment, Ch. 2
Recordkeeping	No reference source specified
Reverse Osmosis	Water Treatment, Ch. 15
Safety Administration	No reference source specified
Science	Basic Science Concepts and Applications, Chemistry 2 - 6
Screening	Water Treatment, Ch. 3
Sludge Centrifuges	No reference source specified
Sludge Conditioning	No reference source specified
Sludge Drying Beds	No reference source specified
Softening	Water Treatment, Ch. 11

Appendix G2 (continued)

Sources & Characteristics	Water Sources, Ch. 1-3 and 6
	Water Treatment, Ch. 2
Storage	Water Transmission and Distribution, Ch. 7
Taste & Odor Control	Basic Science Concepts and Applications, Chemistry 7
	Water Treatment, Ch. 7 and 13
Units of Expression	Basic Science Concepts and Applications, Chemistry 7 and Mathematics 11
Valves	Water Transmission and Distribution, Ch. 3
Well Operation	Basic Science Concepts and Applications, Mathematics 23
	Water Sources, Ch. 2

Appendix H
Cross Connection Control Specialist (CCS)
Examination Information

The examination consists of 100 multiple choice questions. Hand-held numeric calculators may be used. Formulas and conversion factors are provided in each examination packet, and are presented in ***Appendix J***. Below is the exam description.

Applicability of Regulations	X
Approved Backflow Preventers	X
Inspection/Testing Requirement	X
Causes of Backpressure	X
Causes of Backsiphonage	X
Certification Requirements	X
Categories of Contaminants	X
General Definitions	X
Regulatory Definitions	X
Installation Requirements	X
Levels of Protection	X
Minimum CCC Program Elements	X
General Program Requirements	X
Purpose of Regulations	X
Regulatory Responsibilities	X
Backflow Preventer Requirement	X
Risk Assessment	X
Backflow Preventer Selection	X
Testing of Assemblies	X

Study References

See Appendix I

Appendix I
Study Materials

Water Distribution Specialist (WDS)	Water Distribution System O & M – California State University Water Treatment Plant Operation Vol. 2 - California State University AWWA - Operator Certification Study Guide - WETRC AWWA - Water Distribution Training Handbook - WETRC Water Transmission and Distribution – AWWA Bookstore Basic Science Concepts and Applications – AWWA Bookstore
Water Distribution Manager (WDM)	Water Distribution System O & M - California State University Water Treatment Plant Operation Vol. 2 - California State University AWWA - Operator Certification Study Guide - WETRC AWWA - Water Distribution Training Handbook – WETRC Water Transmission and Distribution – AWWA Bookstore Basic Science Concepts and Applications – AWWA Bookstore
Basic Treatment Operator (BTO)	Small Water System Operation and Maintenance, A Field Study Training Program - California State University AWWA - Operator Certification Study Guide - WETRC Group A Public Water Systems Chapter 246-290 WAC - DOH Slow Sand Filtration - ASCE Water Filtration For Point-Of-Use Application - Water Quality Association
Water Treatment Plant Operator (WTPO)	Water Treatment Plant Operation Vol. 1 - California State University Water Treatment Plant Operation Vol. 2 - California State University AWWA - Operator Certification Study Guide - WETRC Manual Of Instruction For Water Treatment Plant Operators – WETRC Water Treatment – AWWA Bookstore Basic Science Concepts and Applications – AWWA Bookstore
Cross Connection Control Specialist (CCS)	Cross Connection Control Manual, Accepted Procedure & Practice Handbook – PNWS-AWWA Manual of Cross Connection Control, 9th Edition – USC Recommended Practice for Backflow Prevention & Cross Connection Control – AWWA Cross Connection Control Manual (WH-550) - USEPA Backflow Prevention Assemblies Approved For Installation In Washington State - DOH

Appendix I (continued)

Prices for study materials vary, therefore, please contact the appropriate source.

Department of Health **Operator Certification Program** PO Box 47822 Olympia, WA 98504-7829 Toll Free 1-800-525-2536 (360) 236-3141 Website: www.doh.wa.gov/ehp/dw	**Washington Environmental Training Center (WETRC)** 12401 SE 320th Street Auburn, WA 98092-0858 Toll Free 1-800-562-0858 (253) 833-9111 Ext 3369 Website: www.wetrc.org	**AWWA Bookstore** 6666 West Quincy Avenue Denver, CO 80235 Toll Free 1-800-926-7337 Website: www.awwa.org
PNWS/AWWA 9100 Mangan Drive Clackamas, OR 97015 1-877-767-2992 or (503) 655-4075	**Water Quality Association** 4151 Naperville Road Lisle, IL 60532-1088 (630) 505-0160 Fax (630) 505-9637 Website: www.wqua.org	**American Society Of Civil Engineers** 1801 Alexander Bell Dr Reston, VA 20191 1-800-548-2723 or (703) 295-6200 Website: www.asce.org
Foundation of Cross-Connection Control and Hydraulic Research **University of Southern California** KAP-200 University Park MC-2531 Los Angeles CA 90089-2531 (213) 740-2032	**CSUS Foundation, Office of Water Programs** 600 J Street Sacramento, CA 95819-6025 (916) 278-6142 Fax (916) 278-5959 Website: www.owp.csus.edu Email: wateroffice@owp.csus.edu	**USEPA** Water Resource Center (RC4100) Room 2615 401 M Street Washington, DC 20460 (202) 260-7786

Appendix J

ABC Formula/Conversion Table for Water Treatment, Distribution and Laboratory Exams

Alkalinity, as mg $CaCO_3/L$ = $\dfrac{(\text{Titrant Volume, mL})\,(\text{Acid Normality})\,(50{,}000)}{\text{Sample Volume, mL}}$

Amps = Volts/Ohms

Area of Circle = $(\Pi/4)$ (Diameter^2) or (Π)(Radius^2)

Area of Cone (lateral area) = (Π) (Radius) $\sqrt{\text{Radius}^2 + \text{Height}^2}$

Area of Cone (total surface area) = (Π) (Radius) (Radius + $\sqrt{\text{Radius}^2 + \text{Height}^2}$)

Area of Cylinder (total outside surface area) = [Surface Area of End #1]+ [Surface Area of End #2] + [(Π)(Diameter)(Height or Depth)]

Area of Rectangle = (Length) (Width)

Area of a Right Triangle = $\dfrac{(\text{Base})\,(\text{Height})}{2}$

Average (arithmetic mean) = $\dfrac{\text{Sum of All Terms}}{\text{Number of Terms}}$

Average (geometric mean) = $(X_1 \times X_2 \times X_3 \times X_4 \times X_n)^{1/n}$ The nth root of the product of n numbers

Chemical Feed Pump Setting, % Stroke = $\dfrac{(\text{Desired Flow})\,(100\%)}{\text{Maximum Flow}}$

Chemical Feed Pump Setting, mL/min = $\dfrac{(\text{Flow, MGD})\,(\text{Dose, mg/L})\,(3.785\text{ L/gal})\,(1{,}000{,}000\text{ gal/MG})}{(\text{Liquid, mg/mL})\,(24\text{ hr/day})\,(60\text{ min/hr})}$

Circumference of Circle = (Π) (Diameter)

Composite Sample Single Portion = $\dfrac{(\text{Instantaneous Flow})\,(\text{Total Sample Volume})}{(\text{Number of Portions})\,(\text{Average Flow})}$

Degrees Celsius = (Degrees Fahrenheit - 32) ($^5/_9$) or $\dfrac{(F^\circ - 32)}{1.8}$

Degrees Fahrenheit = (Degrees Celsius) ($^9/_5$) + 32 or (Celsius) (1.8) + 32

Detention Time = $\dfrac{\text{Volume}}{\text{Flow}}$

Electromotive Force (E.M.F), volts = (Current, amps) (Resistance, ohms) or E =IR

Feed Rate, lbs/day = $\dfrac{(\text{Dosage, mg/L})\,(\text{Capacity, MGD})\,(8.34\text{ lbs/gal})}{(\text{Purity, decimal percentage})}$

Appendix J (continued)

$$\text{Feed Rate, gal/min (Fluoride Saturator)} = \frac{(\text{Plant capacity, gal/min})\,(\text{Dosage, mg/L})}{(18{,}000\ \text{mg/L})}$$

$$\text{Filter Backwash Rise Rate, in/min} = \frac{(\text{Backwash Rate, GPM/sq ft})\ (12\ \text{in/ft})}{(7.48\ \text{gal/cu ft})}$$

$$\text{Filter Drop Test Velocity, ft/min} = \frac{\text{Water Drop, ft}}{\text{Time of Drop, min}}$$

$$\text{Filter Flow Rate or Backwash Rate, gpm/sq ft} = \frac{\text{Flow, gpm}}{\text{Filter Area, sq ft}}$$

$$\text{Filter Yield, lbs/hr/sq ft} = \frac{(\text{Solids Loading, lbs/day})\,(\text{Recovery, \% / 100\%})}{(\text{Filter operation, hr/day})\,(\text{Area, sq ft})}$$

Flow Rate, cfs = (Area, sq ft)(Velocity, ft/sec) or $Q = AV$ where: Q = flow rate, A = area, V= velocity

Force, pounds = (Pressure, psi) (Area, sq in)

$$\text{Gallons/Capita/Day} = \frac{\text{Volume of Water Produced, gpd}}{\text{Population}}$$

$$\text{Hardness, as mg } CaCO_3\text{/L} = \frac{(\text{Titrant Volume, mL})\,(1{,}000)}{\text{mL of Sample}}$$ Only when the titration factor is 1.00 of EDTA

$$\text{Horsepower, Brake} = \frac{(\text{Flow, gpm})\,(\text{Head, ft})}{(3{,}960)\,(\text{Decimal Pump Efficiency})}$$

$$\text{Horsepower, Motor} = \frac{(\text{Flow, gpm})\,(\text{Head, ft})}{(3{,}960)\,(\text{Decimal Pump Efficiency})\,(\text{Decimal Motor Efficiency})}$$

$$\text{Horsepower, Water} = \frac{(\text{Flow, gpm})\,(\text{Head, ft})}{3{,}960}$$

$$\text{Hydraulic Loading Rate} = \frac{\text{Total Flow Applied}}{\text{Area}}$$

$$\text{Hypochlorite Strength, \%} = \frac{(\text{Chlorine Required, lbs})\,(100)}{(\text{Hypochlorite Solution Needed, gal})\,(8.34\ \text{lbs/gal})}$$

$$\text{Leakage, gpd} = \frac{\text{Volume, gallons}}{\text{Time, days}}$$

Mass, lbs/day = (Flow, MGD) (Concentration, mg/L) (8.34 lbs/gal)

Milliequivalent = (mL) (Normality)

Appendix J (continued)

$$\text{Molarity} = \frac{\text{Moles of Solute}}{\text{Liters of Solute}}$$

$$\text{Normality} = \frac{\text{Number of Equivalent Weights of Solute}}{\text{Liters of Solution}}$$

$$\text{Number of Equivalent Weights} = \frac{\text{Total Weight}}{\text{Equivalent Weight}}$$

$$\text{Number of Moles} = \frac{\text{Total Weight}}{\text{Molecular Weight}}$$

$$\text{Reduction in Flow, \%} = \frac{(\text{Original Flow - Reduced Flow})\,(100\%)}{\text{Original Flow}}$$

$$\text{Removal, \%} = \frac{(\text{In} - \text{Out})\,(100)}{\text{In}}$$

$$\text{Slope, \%} = \frac{\text{Drop or Rise}}{\text{Distance}} \times 100$$

$$\text{Solids Concentration, mg/L} = \frac{\text{Weight, mg}}{\text{Volume, L}}$$

$$\text{Solids, mg/L} = \frac{(\text{Dry Solids, grams})\,(1{,}000{,}000)}{\text{Sample Volume, mL}}$$

$$\text{Specific Gravity} = \frac{\text{Specific Weight of Substance, lbs/gal}}{\text{Specific Weight of Water, lbs/gal}}$$

$$\text{Surface Loading Rate, gpd/sq ft} = \frac{\text{Flow, gpd}}{\text{Area, sq ft}}$$

Three Normal Equation $= (N_1 \times V_1) + (N_2 \times V_2) = (N_3 \times V_3)$, where $V_1 + V_2 = V_3$

Two Normal Equation $= N_1 \times V_1 = N_2 \times V_2$, where N = concentration, V = volume or flow

$$\text{Velocity, ft/sec} = \frac{\text{Flow Rate cu ft / sec}}{\text{Area, sq ft}} \text{ or } \frac{\text{Distance, ft}}{\text{Time, sec}}$$

Volume of Cone $= (1/3)\,(\Pi/4)\,(\text{Diameter}^2)\,(\text{Height})$

Volume of Cylinder $= (\Pi/4)\,(\text{Diameter}^2)\,(\text{Height})$

Volume of Rectangular Tank = (Length) (Width) (Height)

Watts = (Volts) (Amps)

Appendix J (continued)

$$\text{Weir Overflow Rate, gpd/ft} = \frac{\text{Flow, gpd}}{\text{Weir Length, ft}}$$

$$\text{Wire-to-Water Efficiency, \%} = \frac{\text{Water Horsepower, HP}}{\text{Power Input, HP or Motor HP}} \times 100$$

$$\text{Wire-to-Water Efficiency, \%} = \frac{(\text{Flow, gpm})\,(\text{Total Dynamic Head, ft})\,(0.746\ \text{kw/hp})\,(100)}{(3{,}960)\,(\text{Kilowatt Demand})\,(\text{Pump Efficiency})}$$

Conversion Factors:

1 acre = 43,560 square feet
1 acre foot = 326,000 gallons
1 cubic foot = 7.48 gallons
1 cubic foot = 62.4 pounds
1 cubic foot per second = 0.646 MGD
1 foot = 0.305 meters
1 foot of water = 0.433 psi
1 gallon = 3.79 liters
1 gallon = 8.34 pounds
1 grain per gallon = 17.1 mg/L
1 horsepower = 0.746 kW or 746 watts or 33,000 ft. lbs./min.
1 mile = 5,280 feet
1 million gallons per day = 694 gallons per minute
1 million gallons per day = 1.55 cubic feet per second (cfs)
1 pound = 0.454 kilograms
1 pound per square inch = 2.31 feet of water
1% = 10,000 mg/L
Π or pi = 3.14

Abbreviations:

cfs	cubic feet per second	MGD	million gallons per day
DO	dissolved oxygen	mL	milliliter
ft	feet	ppb	parts per billion
g	grams	ppm	parts per million
gpd	gallons per day	psi	pounds per square inch
gpg	grains per gallon	Q	flow
gpm	gallons per minute	SS	suspended solids
in	inches	TOC	total organic carbon
kW	kilowatt	TSS	total suspended solids
lbs	pounds	VS	volatile solids
mg/L	milligrams per liter		